MODEL V-422/V-222

OSCILLOSCOPE

OPERATION MANUAL

Hitachi Denshi, Ltd.

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NOTE

- This instrument should be adjusted at an ambient temperature of +20°C for best overall accuracy.
  Allow at least 15 minutes warmup before proceeding.
- Polyvinyl chloride (PVC) film is attached on the enclosure and the front panel of the oscilloscope to protect the metal surface. If the PVC film is damaged by scratches, remove it.
- To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.
- For safety operation, the instrument chassis and cabinet be sure to connect the ground lead of the GND (ground) terminal to earth ground, if a two-wire AC power system is used.
  Failure to complete the ground system may allow the chassis and cabinet of this instrument to be elevated above ground potential and pose a shock hazard.

1. FEATURES

The Hitachi V-422 [V-222]* is a portable-type, advanced-class oscilloscope with a bandwidth of DC to 40 MHz [20 MHz] designed with the emphasis on operability and portability and has a following features.

[ ]* : Specifications of V-222

(1) Wide bandwidth:

The instrument has a bandwidth from DC to 40MHz [20 MHz.]

(2) High sensitivity:

Sensitivity is 1 mV/div

(3) Large 6" screen:

Employment of a large square CRT makes waveforms easier to observe.

(4) Internal graticule:

Employment of an internal graticule CRT permits waveforms observation to be made without parallax error.

(5) DC OFFSET:

Allows a proportionate observation of any part of an input waveform even when it is in a large amplitude.

(6) ALT MAG

Allows simultaneous observation of X1 and X10 sweeping waveforms.

(7) ALT TRIG

Even an observation of two waveforms of different frequencies, the waveform of the each cannel is stably triggered.

(8) TV synchronization:

Employment of a new TV sync separator circuit allows the instrument to observe TV signals stably.

(9) Auto focusing:

Focusing shift is automatically corrected.

2. ACCESSORIES

This instrument is shipped with the following standard accessories.

2 Probes (AT-10AK 1.5)

1 AC power supply cord

1 Operation manual

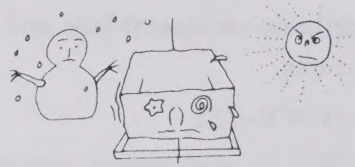
3. PRECAUTIONS

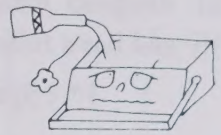
Precautions to be observed to lengthen the service life of this instrument.

Installation site

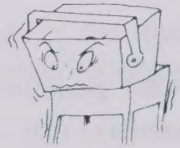
* Avoid installing instrument in an extremely hot or cold place.
  - Avoid placing this instrument in a place exposed to sunlight for a long period of time, in a closed car in midsummer, or near a room heating device such as a stove.
  - The operating maximum ambient temperature is +40°C.
* Do not use instrument that has been left outdoors on a cold winter day.
  The operating ambient temperature is 0°C or more.

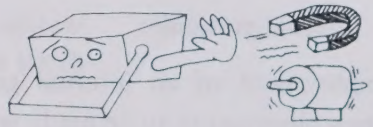
* Avoid moving the instrument rapidly from a hot place to a cold place of vice versa, or condensation may form on inside of the instrument.
* Keep the instrument away from damp air, water, and dust. Unexpected trouble may be caused when the instrument is placed in a damp or dusty place.
  The operating ambient humidity is 35–85%.
  Since an accidental intrusion of water may also cause troubles, do not place a water-filled containers such as a vase on the oscilloscope.





* Do not place the instrument in a place where vibration is strong. Avoid using the instrument at a place vibrating violently. Since the oscilloscope is a precision instrument, excessively strong vibrations may cause damage.
* Do not place the instrument near a magnet or magnetic body. An oscilloscope is an equipment using electron beam. Therefore, do not bring a magnet close to the instrument or do not use the instrument near an equipment generating strong magnetic force.

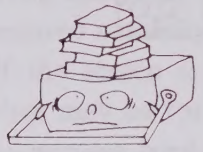




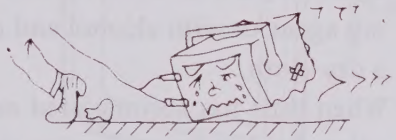
Handling

* Do not put a heavy objects on the oscilloscope.
* Do not block the ventilation holes.

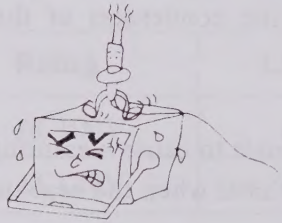
* Do not apply a heavy shock to the oscilloscope.



* Do not insert a wire, pin, etc. through the ventilation hole.
* Do not drag the set, leaving the probe attached to it.



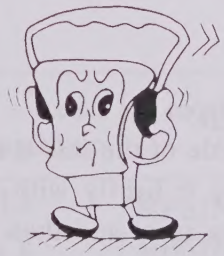
* Do not leave a hot soldering iron on the cabinet or the screen.
* Do not try to turn the instrument upside down. Otherwise, knobs may be broken.



* Do not use the instrument upright, leaving BNC cable connected to EXT BLANKING terminal on the rear panel. Otherwise, the cable may be damaged.

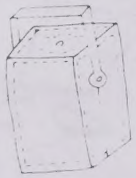
Handle

The handle of the V-422 [V-222] can be positioned for carrying or as a tilt-stand for the instrument. To position the handle, press in at both pivot points and turn the handle to the desired position. 13 positions are provided for convenient carrying or viewing.



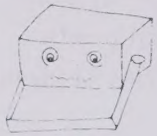
When not in use

When not in use, put the dust-proof cover on the instrument and store it with care.



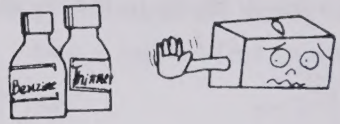
When operation is faulty

Recheck the operating procedure and if problem persists, contact a nearly service station or agent.



Care and repair

* Removal of stain from the case.
  - When the outside of the case is stained, remove the stain by first wiping it lightly with a cloth moistened with neutral washing agent and then wipe the surface with a dry cloth.
* Never use strongly volatile agent such as benzine and thinner.



  - When the panel surface is stained, remove the stain in similar way with a clean, soft cloth. When heavy stains are present, first remove the stains by wiping the surface lightly with a cloth moistened with diluted neutral washing agent or with alcohol and then wipe thoroughly with a dry cloth.
  - When dust has accumulated on the inside, remove it by using dry brush, or by using the exhaust of a compressor or a vacuum cleaner.

NOTE: When opening the case, pull out the power supply plug beforehand without fail.
When cleaning the inside, insure beforehand that no electricity remains in the condensers of the power supply circuit.

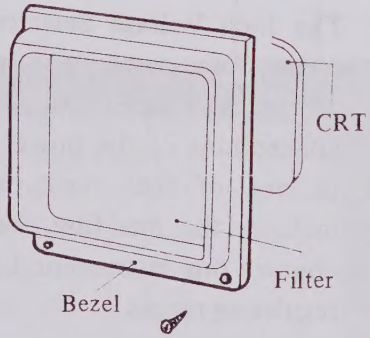
* Cleaning of CRT

Dirty surface of CRT screen tends to cause measuring errors. The screen surface becames visible when the bezel is removed.

Remove the stains on CRT and filter by using a clean and soft cloth, paying attention not to impair them.

When the stain is extremely heavy, wash them with neutral washing agent and then leave them stand until the moisture is removed naturally.

- If the screen is installed while it is moistened, water rings may be formed and the waveform may be blurred to become hard to observe. Pay attention not to leave finger prints on it.



Operation precautions

* **Check the line voltage.**

The operating voltage range of this oscilloscope is as shown below. Check the line voltage without fail before turning on the power switch.

Rating	Line Voltage (50/60Hz)
AC100V	AC 90V – 110V
AC120V	AC108V – 132V
AC220V	AC198V – 242V
AC240V	AC216V – 264V

Nominal volts ±5% at 400Hz.

In the case of normal shipment, the voltage selector will be set convenient for user up. When it is intended to use the oscilloscope on voltages other rating, voltage selector can be turned. (Rated voltages are indicated on the rear panel of the oscilloscope.)

* **Use only specified fuses.**

In order to protect the circuit against overcurrent, a 2A (make use of AC100V or AC120V) or 1A (make use of AC220V or AC240V) is used on the primary side of the power supply. When this fuse is below out, check thoroughly the cause, repair any faulty point present, and then replace with a specified fuse. Do not try to use the fuse other than the specified ones. Otherwise, fault may be caused or danger may be invited.
(Particularly, do not use a fuse different from the specified one in current capacity and in length.) The standards if the fuses are as follows.

	Shape (Diameter x length) mm	JIS type name
2A	6.35ϕ x 31.8	MF61NM250V 2A AC
1A	6.35ϕ x 31.8	MF61NM250V 1A AC

* **Do not increase the brightness too much.**

Do not increase the brightness of the spot and trace too much. Your eyes may be strained and the fluorescent surface of CRT may be burnt.

* **Do not apply an excessive voltage.**

The input withstand voltage of each input connector and probe input is as follows. Never apply a voltage higher than specified.

INPUT direct,	300V (DC + AC peak at 1 kHz)
When x10 probe is used	400V (DC + AC peak at 1 kHz)
When x 1 probe is used	300V (DC + AC peak at 1 kHz)
EXT TRIG INPUT	300V (DC + AC peak)
EXT BLANKING	30V (DC + AC peak)

Calibration Interval

To maintain instrument accuracy, perform the calibration of the V-422 [V-222] at least every 1000 hours of operation, or every six months if used infrequently.

4.CONTROLS AND CONNECTORS

(1) Power supply and CRT

Operating voltage fuse

This model can be operated from either a 100-volt, a 120-volt, a 220-volt or a 240-volt nominal line voltage source.

The Line Voltage Selector assembly on the rear panel converts the instrument from one operating range to the other. In addition, this assembly changes the primary connections of the power transformer to allow selection of one of four regulating ranges. The assembly also includes the line fuse. Use the following procedure to convert this instrument between nominal line voltage or regulating ranges.

1. Disconnect the instrument from the power source.
2. To convert from 100-volts nominal to 220-volts nominal line voltage or vice versa, pull out the Voltage Selector switch turn it, and plug it back into the remaining holes. Change the line-cord power plug to match the power-source receptacle.
3. Before apply power to the instrument, check that the indicating tabs on the rear panel.

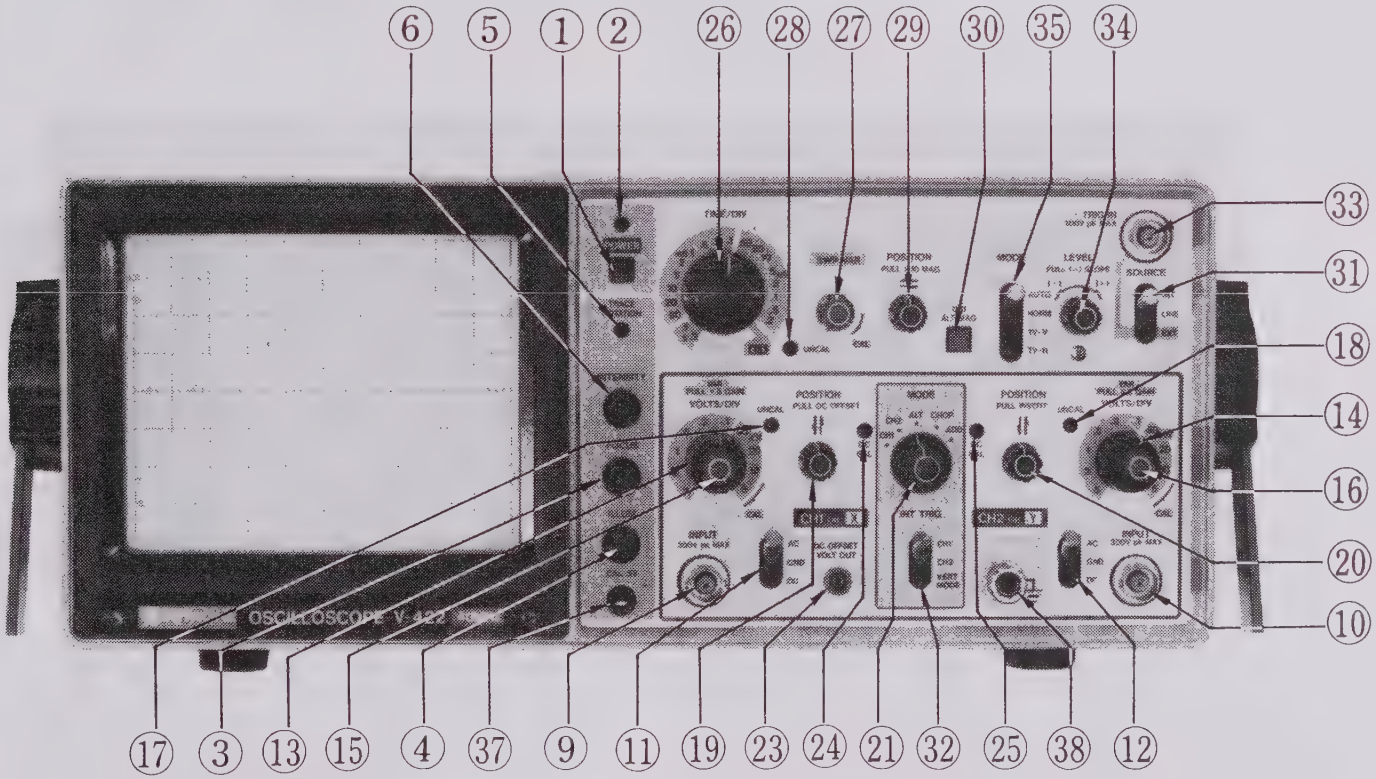


Fig. 4-1 V-422 Front View

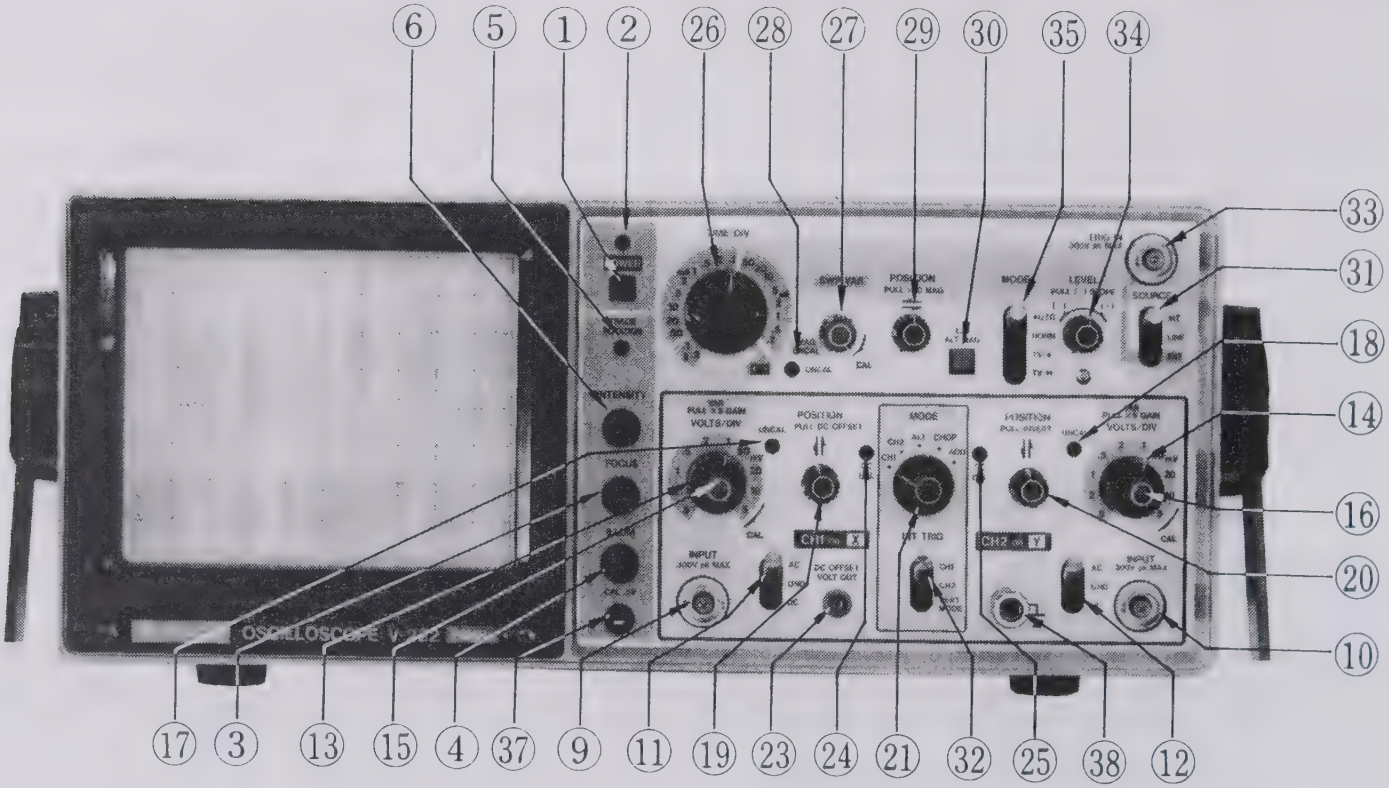


Fig. 4-2 V-222 Front View

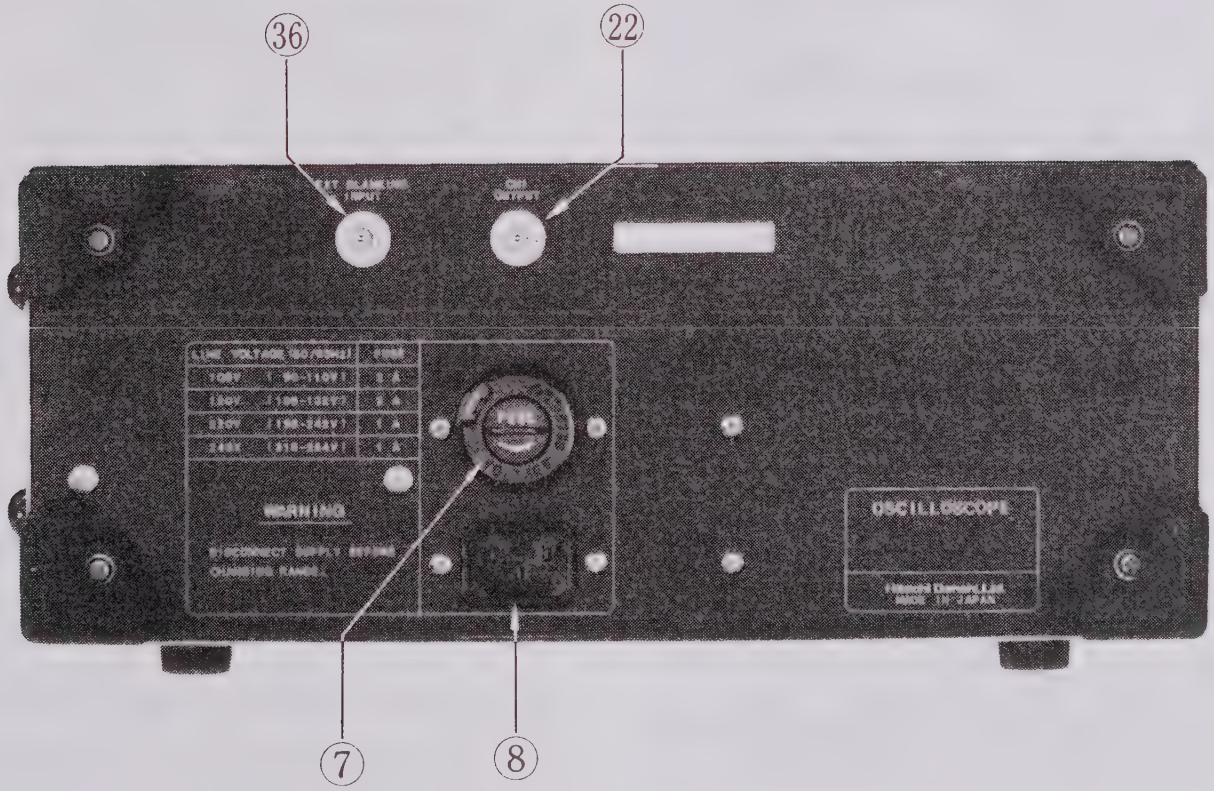


Fig. 4-3 V-422/V-222 Rear View

① **POWER switch**

The POWER is set on at the pushed-in position, and set off at the released position.

② **POWER lamp**

This lamp goes on in red when tne power supply is in ON state.

③ **FOCUS control**

After obtaining an appropriate brightness by operating INTENsity, adjust FOCUS until the bright line is clearest. Although the focus is also corrected automatically when INTEN is rotated, the focus is sometimes slightly shifted.

④ **SCALE ILLUM control**

Controls graticule illumination. Useful to illuminate the graticule when viewing in a dark area, photographing.

⑤ **TRACE ROTATION control**

Used to aline the trace of CRT with the horizontal graticule.

⑥ **INTEN sity control**

This knob also works as the brightness adjust variable resistor. Brightness is increased by rotating INTENsity clockwise.

⑦ **Power source select switch**

Used to select the power sources.

⑧ **AC INLET**

This is inlet for detachable AC power cord.

(2) Controls of vertical deflection system

⑨ **CH1 INPUT connector**

BNC connector for vertical axis input.
The signal input to this terminal becomes the X-axis signal when the instrument is used as an X-Y oscilloscope.

⑩ **CH2 INPUT connector**

The same as CH1, but when the instrument is used as an X-Y oscilloscope, the signal input to this terminal becomes the Y-axis signal.

⑪ ⑫ **Input coupling switches (AC-GND-DC)**

The switches used to select the coupling system between the input signal and vertical axis amplifier.

AC At this setting the signal is connected through a condenser. The DC component of the input signal is cut off and only the AC component is displayed.

GND At this setting the input to the vertical axis amplifier is grounded.

DC At this setting the input signal is directly connected to the vertical axis amplifier and displayed unchanged, including the DC component.

⑬ ⑭ VOLTS/DIV select switches

A step attenuator which selects vertical deflection factor. Set it to an easily observable range corresponding to the amplitude de of the input signal.
Multiply the reading by 10 when the 10:1 probe is used in combination with the instrument.

⑮ ⑯ VAR PULL x5 GAIN controls

Fine tuning device used to vary the vertical deflection sensitivity continuously. Attenuation of less than 1/2.5 is obtained when this device is rotated in the reverse direction of the arrow to the full.
This control is used when comparing waveforms or when measuring the rise time of a square wave in 2-channel observation. Normally this control is left rotated in the direction of the arrow to the full. When the knob is at PULL position (pulled up state) the gain of the vertical axis is magnified 5 times and the maximum sensitivity becomes 1mV/DIV.

⑰ ⑱ UNCAL lamp

Light when VAR is out of CAL detent position.

⑲ POSITION PULL DC OFFSET control

This knob used to adjusting the position of the vertical axis.
The image rises with the clockwise rotation of this knob and falls with the counterclockwise rotation.
A magnified input waveform is made available by pulling out the knob.
(Keep pushed-in for the normal operation.)

⑳ POSITION PULL INVERT control

The same as CH1, but when the knob is at PULL position (pulled up state), this is used to inverse the polarity of the input signal applied to CH2.
This control is conveniently used in the comparison of two waveforms having different polarity or in the observation of the waveform of the difference signal (CH1) – (CH2) between CH1 and CH2 using ADD.

㉑ MODE select switch

This switch is used to select the operation mode of the vertical deflection system.

CH1 Only the signal that has been applied to CH1 appears on the screen.

CH2 Only the signal that has been applied to CH2 appears on the screen.

ALT Signals applied respectively to CH1 and CH2 appear on the screen alternatively at each sweep. This setting is used the sweep time is short in 2-channel observation.

CHOP At this setting the input signals applied respecting to CH1 and CH2 are switched at about 250 kHz independent of the sweep and at the same time appear on the screen. This setting is used when the sweep time is long in 2-channel observation.

ADD The algebraic sum of the input signals applied respectively to CH1 and CH2 appears on the screen.

(22) CH1 OUTPUT connector

Output connector providing a sample of the signal applied to the CH1 connector.

(23) DC OFFSET VOLT OUT connector

This is the output connector to readout the voltage measurement with a digital multi-meter, etc., when the instrument is set to the DC OFFSET mode. (Except : x5 GAIN, out of CAL)

(24) (25) DC BAL adjustment controls

There are used for the ATT balance adjustment.
See 8. ADJUSTMENTS . . . for the details.

(3) Controls of Horizontal deflection system

(26) TIME/DIV select switch

Sweep time ranges are 19 steps from 0.2 μs/div to 0.2s/div.

X-Y This position is used when using the instrument as an X-Y oscilloscope.
In this position the X (horizontal) signal is connected to the input of CH1; the Y (vertical) signal is applied to the input of CH2 and has a deflection range from less than one millivolt to 5 volts/div at a reduced band-wide of 500 kHz.

(27) SWP VARiable control

This control works as CAL and the sweep time is calibrated to the value indicated by TIME/DIV.
TIME/DIV of sweep can be varied continuously when shaft is out of CAL position.
Then the control is rotated in the direction of arrow to the full, the CAL state is produced and the sweep time

is calibrated to the value indicated by TIME/DIV. Counterclockwise rotation to the full delays the sweep by 2.5 times or more.

㉘ **Sweep UNCAL lamp**

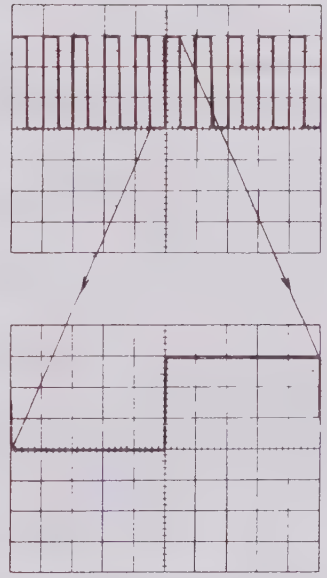
Light when SWP VAR is out of CAL detent position.

㉙ **POSITION PULL ×10 MAG control**

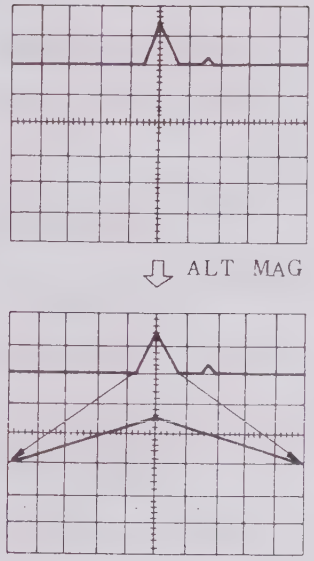
This knob is used to move the bright line in horizontal directions. It is indespensable in the measurement of the time of waveform.

Bright line is moved toward right when the knob is rotated clockwise and toward left with counterclockwise rotation.

Sweep is magnified 10 times by pulling out knob of POSITION. In this case the sweep times is 1/10 of the value indicated by TIME/DIV. Bring the position of the waveform desired to be magnified observed to the outer of the scale by operating ⇄ POSITION of the horizontal axis. Next, switch ×10 MAG switch to PULL (pulled out state). Then the waveform placed at the center is magnified in right and left directions. The sweep time in this case is 10 times the sweep speed obtained by TIME/DIV, in other words, the reading is 1/10 of the sweep time indicated.



Magnified waveform



ALT MAG function
(×1 waveform and ×10 waveform)

㉚ **CH1 ALT MAG switch**

CH1 input signal is displayed alternately by each single sweep of X1 (NORM) and X10(MAG).

- ○ Set the wished portion of the waveform to the screen center for magnification.
- ○ The X10 waveform appears 3 divisions below the X1 waveform.

(4) Synchronization system

(31) SOURCE select switch

This switch is used to select the triggering signal source sweep.

INT The input signal applied to CH1 or CH2 becomes the triggering signal.

LINE This setting is used when observing a signal trigering with power supply line frequency.

EXT External triggering signal applied to TRIG INPUT becomes the triggering signal.
This setting is used when triggering with a special independently of the vertical axis signal.

(32) INT TRIG select switch

This switch is used to select the internal triggering signal source sweep.

CH1 The input signal applied to CH1 becomes the triggering signal.

CH2 The input signal applied to CH2 becomes the triggering signal.

VERT MODE For observing two waveforms, the sync signal changes alternately corresponding to the signals on CH1 and CH2 to trigger the signal.

(33) TRIG INput connector

Input terminal for use for external triggering signal of sweep

(34) TRIG LEVEL control

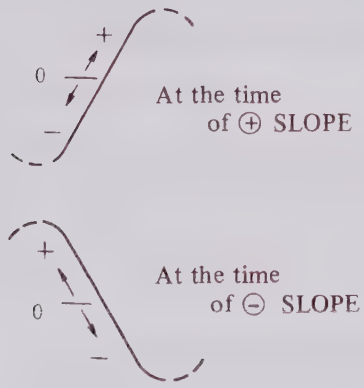
This knob is used to decide at which portion of the waveform should the sweep be started by setting trigger level. This knob is also enabled to switch SLOPE.
Depressed position (normal state) is for ⊕ SLOPE and PULL position (state in which the knob is protruding) is for ⊖ SLOPE.

Explanation of synchronization polarity SLOVE

Push
at time of
⊕SLOPE

Pull
at time of
⊖ SLOPE

Explanation of synchronization level LEVEL



㉟ TRIG MODE select switch

AUTO The instrument is brought into automatically triggering sweep in which sweep is always conducted.
In the presence of triggered signal, normal triggered sweep is obtained and the waveform stands still. In the case of no signal or out of triggering, sweep line will appear automatically. This setting is convenient in usual cases.

NORM Triggered sweep is obtained and sweep is conducted only when triggering is effected. No sweep line will appear in the case of no signal or out of synchronization. Use this MODE when effecting synchronization to a very low frequency signal (25 Hz or less).

TV(V) This setting is used when observing the entire vertical picture of television signal.

TV(H) This setting is used when observing the entire horizontal picture of television signal.

(NOTE) Both TV V and TV H synchronize only when the synchronizing signal is negative.

(5) Miscellaneous

㊱ EXT BLANKING connector

Input terminal for brightness modulation. It is of the DC coupling. The brightness is reduced with a positive signal and increases with a negative signal.

㊲ CAL 0.5V tip

Output terminal of calibration square wave of about 1kHz and 0.5V. It has a tip terminal. It is used to calibrate the probe combination.

㊳ GND terminal

Earth terminal of the oscilloscope.

5. HOW TO PRODUCE THE BRIGHT LINE

Before turning ON the POWER switch, insure the power supply voltage is within the range of 108–132V for AC 120V set, 198–242V for AC 220V set, and 216–264V for AC 240V set.

Insert the plug of the power cord on the rear panel into the power supply wall socket and set the controls as follows.

POWER	OFF
INTEN	Counterclockwise to the full
FOCUS	Midrange
AC-GND-DC	GND
↕ POSITION	Midrange (the knob is in the depressed)
V. MODE	CH1
TRIG	AUTO
TRIG SOURCE	INT
INT TRIG	CH1
TIME/DIV	0.5 ms/div
↔ POSITION	Midrange

Set all the levers of the switches to the upper side.

After ending all the setting mentioned above, turn ON the POWER and, 15 second later, rotate the INTEN knob clockwise. Then the sweep bright line will appear. If the observation is to be started immediately, set the FOCUS control at a point where the bright line is sharpest.

If the instrument is not used with the power supply turned on rotate the INTENsity counterclockwise to reduce the brightness and also blur the FOCUS.

NOTE

For usual observation, leave the following non-calibrating function section set to "CAL" position.

VARIABLE	Rotate in the direction of arrow. In this case the VOLTS/DIV is calibrated to its indicating value.
SWP VAR	Leave the knob in depressed state. In this case the TIME/DIV is calibrated to its indicating value.

Align the bright line with the horizontal scale line at the center of the screen by operating CH1 POSITION. In some cases the bright line may be oblique to the scale slightly by the effect of earth magnetism. In this case, bring the bright line until it lies on the horizontal scale line at the center of the screen by properly adjusting the semi-fixed variable resistor TRACE ROTATION on the front panel.

GENERAL MEASUREMENT

(1) In the case of observing a single waveform.

Use CH1 or CH2 when not observing the phase difference between two waveforms or when engaging in a operation other than X-Y operation. Make the following settings when using CH1.

MODE Switch of Vertical defection system	CH1
MODE Switch of TRIG	AUTO
TRIG SOURCE	INT
INT TRIG	CH1

Under these settings almost all the repetitive signals of about 25 Hz or more applied to CH1 can be synchronized and observed by adjusting TRIG LEVEL. Since the MODE of horizontal axis is at AUTO position, the bright line appears even when no signal is present or when input coupling switch is at GND position. This means that the measurement of DC voltage can be measured. The following switching is needed when observing low frequency signals of about 25 Hz or less.

MODE of TRIG	NORM

Synchronization can be effected by operating LEVER knob under this setting.

When using only CH2, use the instrument after making the following settings.

MODE Switch of Vertical Axis	CH2
TRIG SOURCE	INT
INT TRIG	CH2

(2) When observing two waveforms

Observation of two waveforms can be made easily by setting the MODE switch of vertical axis to ALT or CHOP. When observing two waveforms of high repetition frequencies set the MODE switch to ALT and, in the case of low frequencies, set it to CHOP.

When measuring the phase difference, measure after effecting synchronization with leading phase signal.

6. METHOD FOR CONNECTING SIGNALS

The first step of measurement is introduce the signal desired to measure to the oscilloscope properly. Do it with utmost care.

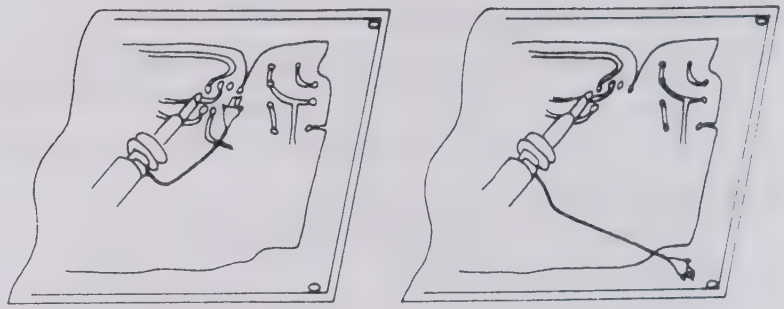
(1) When using a probe

Use the attached probe, AT-10 AK 1.5, when measuring a high frequency wave with high accuracy.
It should be noted, however, that since the input signal is attenuated by this probe to 1/10 before it is input to the oscilloscope the use of the probe is disadvantageous for low signals, and that at the same time the measuring range is extended by that amount for high signals.

<CAUTIONS>

- Do not apply a signal which exceed 400V (DC + peak AC at 1 kHz).
- Bring the grounding point of the earth lead wire of the probe close to the point to be measured when measuring a rapid rising signal or a high frequency signal. Long earth lead wire may cause waveform distortions such as ringing and overshoot.

Connection of earth lead wire



(a) A good example (b) A bad example

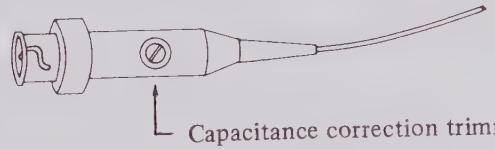
For better measurement it is required to use an earth attachment available at option.

- Multiply the reading of VOLTS/DIV by 10.
  For example, if the VOLTS/DIV is 50mV/DIV, then read the waveform as

  500 mV/div x 10 = 500 mV/div

- To avoid measurement error, put the probe in the following correction state and check it before measurement without fail.
  Connect the tip of the probe to the output terminal CAL 0.5V of 1kHz calibration square wave voltage. When this correction capacity value is at optimum the waveform takes the shape as shown in Fig.(a) as follows.

If the waveform is as shown in Fig. (b) or Fig. (c), rotate the semifixed adjusting screw on the matching box of the probe by using a screwdriver until the optimum state is obtained.



(a) Optimum (b) Capacity too small (c) Capacity too large

(2) At time of direct connection

When connecting a signal directly to the oscilloscope not using the attached probe AT-10 AK 1.5 (10:1), pay attention to the following points in order to minimize the measurement error.

- When performing observation using a bare lead wire, no trouble occurs of the circuit to be measured is of low impedance and high level.
  However, note that, in most cases, measurement error may be caused by static stray coupling with other circuit and power line.
  This measurement error cannot be ignored even in low frequency region.
  In general, it is safe to avoid measuring with non-shielded connecting wire. When using a shielding wire connect one end of the shield to the earth terminal of the oscilloscope and the other end to the grounding of the circuit to be measured. It is desirable to use a coaxial cable with BNC type connector.
- The following cautions must be observed when performing a wide band measurement. It is necessary to terminate with the characteristic impedance of the cable when measuring a rapid rising waveform or a high frequency wave.
  Especially when using a long cable, the absence of a terminating resistor will necessarily lead to a measurement error derived from ringing phenomenon. Some measuring circuits require a terminating resistor equal to the characteristic impedance of the cable also on the measurement terminal side.
  BNC type terminating resistor (50 Ω) is conveniently used for this purpose.
- In order to perform measurement with the measuring circuit put in proper operating state it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit to be measured.
- The stray capacity of the shield wire must be taken into account when performing measurement with a long shield wire. Since the shield wire normally in use has

a capacity of about 100 pF per meter, its effect on the circuit to be measured cannot be ignored. Use a probe to minimize the effection the circuit.

- ○ When the length of the shield wire used or when the length of the non-terminated cable reaches 1/4 wave length or its multiples within the band of V-422 [V-222] type (1/4 wave length is about 1.5 meter [about 3 meter]) when using a coaxial cable at 40MHz [20 MHz], oscillation may be caused near 5 mV/DIV range.
  This is caused by the resonance between the externally connected high-Q inductance and the input capacity and can be avoided by reducing the Q.
  Connect the cable or shield wire to the input connector by way of a serially connected 100Ω to 1 kΩ resistor, or perform measurement at other VOLTS/DIV range.

(3) When observing waveform with X-Y

Set the TIME/DIV switch to X-Y. Then the instrument works as an X-Y oscilloscope.
Each input is applied to the instrument as follows.

X-axis signal (horizontal axis signal)	CH1 INPUT
Y-axis signal (vertical axis signal)	CH2 INPUT

In this case leave the horizontal axis mangnification switch (PULL-MAG ×10 knob) at depressed position.

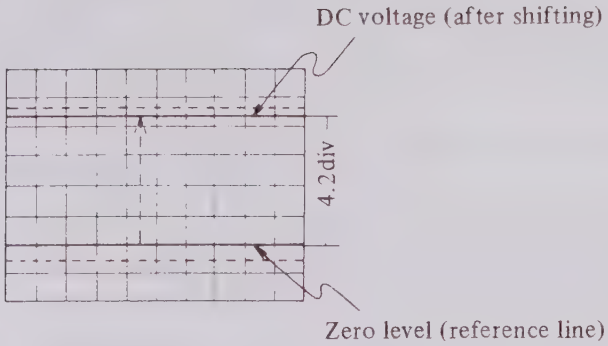
7. MEASURING PROCEDURE

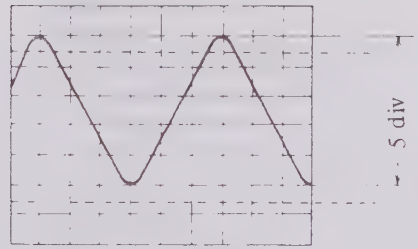
The first things to do are as follows.

- ○ Bring the brightness and FOCUS at optimum positions for easy read out.
- ○ Display the waveform as large as possible to minimize the read error.
- ○ Check the capacity correction when using a probe.
  (Refer to Paragraph (1) "When using a probe" of Section 6 . "Method for connecting signals" for the method for correcting capacity.)

(1) DC voltage measurement

Set input coupling to GND and decide the zero level properly.
Set VOLTS/DIV appropriately and set AC-GND-DC to DC. Since the bright line shifts here by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift width by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/DIV, then 50 mV/div ×4.2 = 210 mV/However, if the probe AT-10 AK 1.5 is in use, the true value of the signal becomes 10 times the value, or 50 mV/div × 4.2 × 10 = 2.1V.)





(2) AC voltage measurement

The same as paragraph 7 (1), "DC voltage measurement", but here those is no need of matching the zero level with the scale line. Move the zero level at will to a position easy to observe.

In the drawing is follows, VOLTS/DIV is 1V/DIV, 1V/div ×5 = 5 Vp-p (50 Vp-p at time using the prove AT-10AK 1.5). When magnifying and observing a small-amplitude signal, superimposing on a high DC voltage, set input coupling of AC. The DC voltage is cut off and AC voltage can be observed by increasing sensitivity.

(3) Measurement of frequency and period

This will be explained taking the drawing at follows as an example.

One period covers the time A and time B, which are separated from each other by 2.0 div on the screen.

When the sweep time is 1 ms/DIV, the period is given by

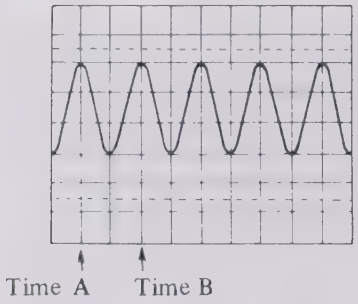
$$1 \text{ ms/div} \times 2.0 = 2.0 \text{ ms}$$

$$= 2.0 \times 10^{-3} \text{ s}$$

Accordingly, the frequency is

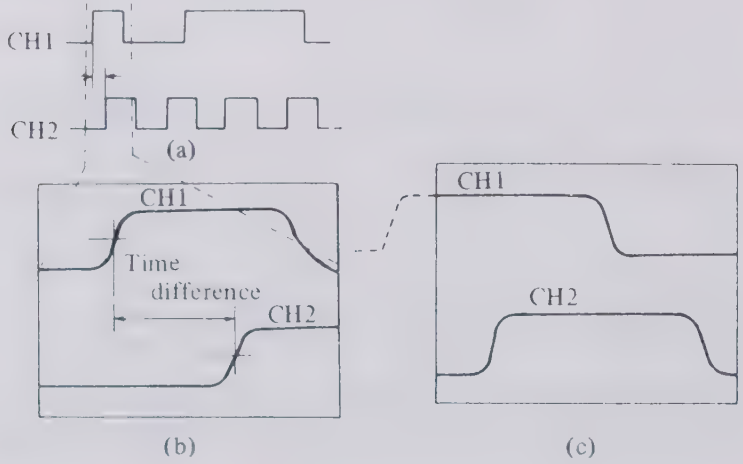
$$1/(2.0 \times 10^{-3}) = 500 \text{ Hz}$$

(However, when the knob MAG x 10 is at pulled out position, TIME/DIV must be converted to 1/10 since the sweep is magnified.)



(4) Measurement of time difference

Triggering signal source "SOURCE" is selected as offering reference signal when measuring the time difference between two signals. Assume that pulse trains as shown in (a). Then (b) shows the case when CH1 is taken as the triggering signal source and (c) the case where CH2 is taken.

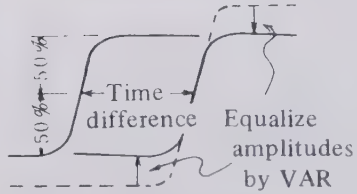


This means that CH1 is used as the triggering signal when investigating the length of time by which the signal of CH2 is delayed from the signal of CH1. CH2 is used in the reversed case. In other words, the signal leading in phase is selected as the triggering signal source.

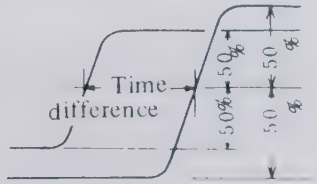
If this process is reversed, the portion to be measured may sometimes not appear on the screen. Thereafter, equalize the amplitudes of the two signals appearing on the screen or superimpose one on another.

Read the time difference by the interval between 50% amplitude points of the two signals.

Sometimes the superimposing method is more convenient from the point of view of procedure.



(a) Equal amplitude measuring method



(b) Suerposition measuring method

<CAUTIONS>

Since the pulsed wave contains many high-frequency wave components (higher harmonics) depending on its width or

period, pay the same attention as given to high frequency signals when handling it. Accordingly, use a probe or coaxial cable and shorten the earth lead wire as much as possible.

(5) Measurement of rise (fall) time

To measure the rise time pay attention not only to the abovementioned items but also to measurement error.
The following relationship exists between the rise time Trx of the waveform to be measured, the rise time Trs of oscilloscope, and the rise time Tro displayed on the screen.

$$Tro = \sqrt{Trx^2 + Trs^2}$$

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope (7ns in our case), the effect of the rise time of the oscilloscope on the measurement can be neglected. However, if both are close to each other, measurement error may be caused.

The true rise time is given by

$$Trx = \sqrt{Tro^2 - Trs^2}$$

Moreover, in general, in a circuit free from waveform distortion such as overshoot and sag, the following relationship is established between frequency band and rise time.

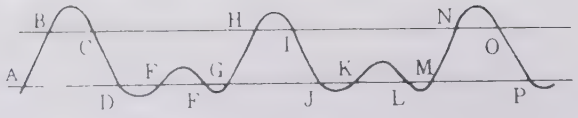
$$f_c \times t_r = 0.35$$

Where, f_c : Frequency band (Hz)
tr : Rise time (s)

The rise time and fall time are determined by the time elapsed between the 10% to 90% values of pulse width. This oscilloscope is provided with graduations for 0%, 10%, 90%, and 100% on the screen, which facilitate measurement.

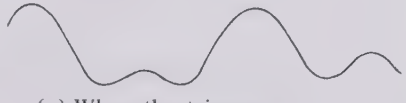
(6) Synchronization of complexed waveform

In the case shown in the Fig. (a) below where two waveforms greatly different in amplitude alternate, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected as Y line two waveforms, one starting with A and advancing to B, C, D, E, F, . . . and the other starting with E and advancing to F, G, H, I . . . , will appear alternately on the screen. They will be doubled as shown in Fig. (b), for which no synchronization can be taken.
In such a case, rotate LEVEL clockwise until the trigger level comes to Y′ line. Then the waveform on the screen becomes the one is shown in Fig. (c) above which start with B and advances to C, E, F, . . . and which allows synchronization.



(a) Signal waveform

(b) When the trigger setting level is Y



(c) When the trigger setting level is Y'

Synchronization of complexed waveform

(7) Synchronization of observing two waveforms

① When two signals of CH1 and CH2 have same frequencies or the frequencies of an integral number or the frequencies in a relation of a specific time difference, the INT TRIG switch selects either CH1 or CH2 as a reference signal. CH1 position selects CH1 signal as a reference, and CH2 position selects CH2 signal.

② For an observation of signals of different frequencies, set the INT TRIG switch to the VERT MODE. The sync signal switches at each alternation of channels, and the waveform of the each channel is stably triggered.

SELECTION OF A TRIGGER SOURCE ON THE VERT MODE

A. Trigger signal is obtained in the following steps.

1) Set the SOURCE switch (31) to INT.
2) Set the INT TRIG switch (32) to VERT MODE.
3) Select the MODE switch (21).

Table 1.

Relation of trigger signal sources and switches

SOURCE		INT			LINE	EXT
INT TRIG		CH1	CH2	VERT MODE	Line	External
V MODE	CH1	CH1	CH2	CH1		
	CH2	CH1	CH2	CH2		
	ALT	CH1	CH2	CH1 CH 2(ALT)		
	CHOP	CH1	CH2	ADD		
	ADD	CH1	CH2	ADD		

When the SOURCE switch to INT, INT TRIG switch to VERT MODE, and MODE switch to ALT, the input signals applied to CH1 and CH2 become trigger source alternatively at each sweep. Consequently, even for an observation of two waveforms of different frequencies, the waveform of the each channel is stably triggered.

In this case, the signal should be applied to both CH1 and CH2, and the two signals have the same level portion in excess of the rated amplitude each other. There should be a common portion of levels available that is above the rated amplitude of CH1 and CH2.

When a sinewave is applied to CH1, and a square wave is applied to CH2, "A"s in Fig. 1 are the levels possible for synchronization.

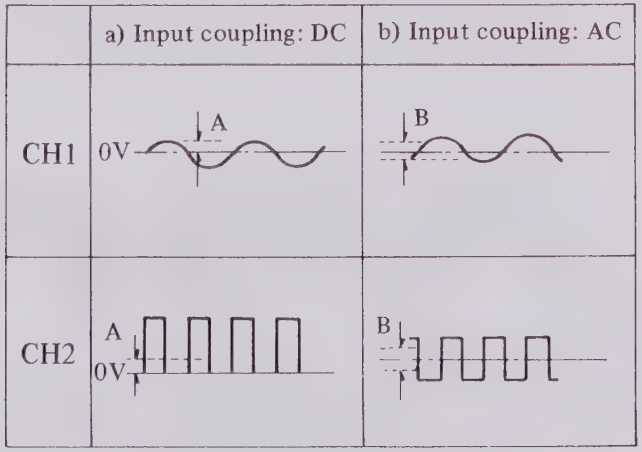


Fig. 1

In order to expand the synchronization range, AC coupling is applied to the CH2 side.

When either the CH1 or CH2 input signal is smaller as shwon in Fig.2 , adjust the VOLTS/DIV switches (13) and (14) to obtain sufficient amplitudes.

The VERT MODE triggering requires 1.5 div more than the amplitude required for an observation of CH1 or CH2.

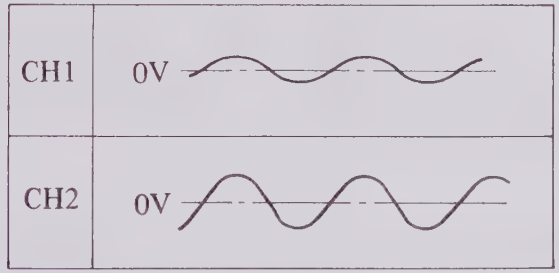


Fig. 2

The VERT MODE triggering is not possible when the signal is applied to only one channel as illustrated on Fig.3.

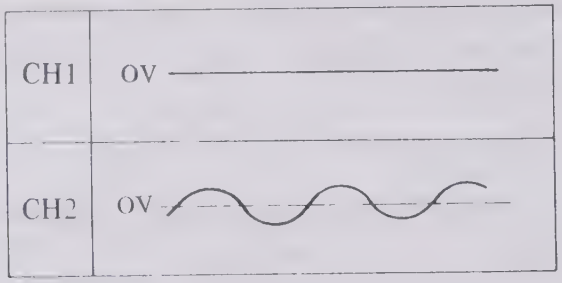
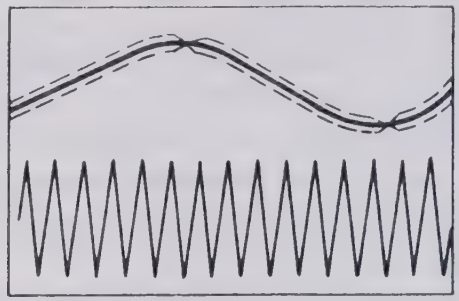


Fig.3

Caution: Do not use the INT TRIG to the VERT MODE when VAR PULL x5 GAIN ⑮ and/or ⑯ are in the pulled out position (x5 GAIN mode).

ALTERNATE TRIGGER

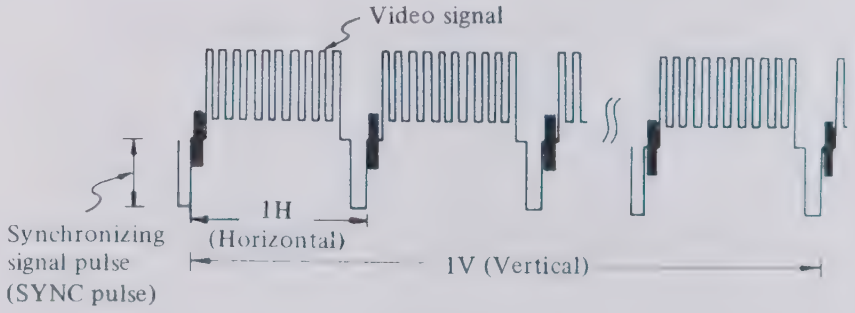
Jittering wave as shown below may appear on the screen when a gently-sloping signal is displayed by approximately 10 cycles or less, with the VERT MODE for the INT TRIG switch and the ALT position for the MODE select switch. For detailed and clear observation of each signal, set the MODE select switch to the CH1 or CH2.



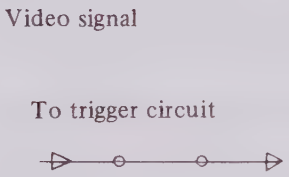
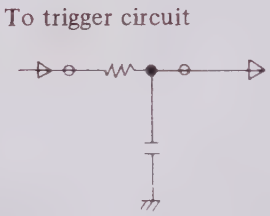
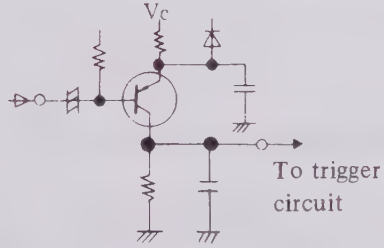
(8) How to use TV exclusive synchronization

① On the image waveform of TV

In the work concerned with TV, complexed signals containing video signal, blanking pedestal sitgnal, and synchronizing signal are often measured. However, since the waveform is complexed, a special circuit is needed to effect a stable synchronization with vertical waveform.

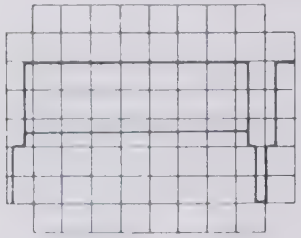


② **Difference in the circuits**

	Exclusive circuit for conventional oscillograph		Exclusive circuit for this instrument (Principle drawing)
	General circuit	**Simple synchronizing circuit**	**TV exclusive synchronizing separator circuit**
Circuits			
	Hard to synchronize, because video signal is applied directly as trigger signal.	Synchronization is more easily effected than in the circuit shown at left, because the signal is integrated to remove high frequency components.	Stable synchronization is ontained since SYNC pulse is picked up, amplified, and then integrated to remove high frequency components.

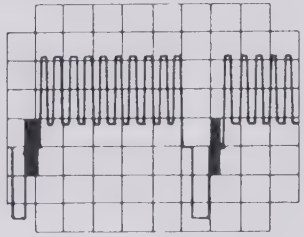
③ Operation

To observe vertical signal



TRIG MODE: TV-V

To observe horizontal signal



TRIG MODE: TV-H

(NOTE) This oscilloscope synchronizes with only (–) synchronizing signal.

(REFERENCE)

(a) Example of (-) synchronizing signal

(b) Example of (+) synchronizing signal

(9) DC OFFSET

The oscilloscope provides the DC offset voltage display of ±1 to ±100V according to the range.
An output terminal for voltage reading.
(Except : x5 GAIN, out of CAL)

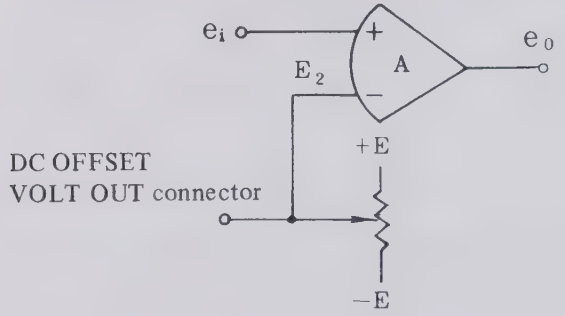


Fig. 7–1 Diagram of DC OFFSET

See Fig. 7–1 for the function of the DC OFFSET.
There is following relation among the differential amplifier output voltage e_0, the input voltages ei and E_2.

$$e_0 = A\,(e_i - E_2)$$

$$e_i = E_{DC} + e_{AC}$$

(Where E_{DC} is a DC input and e_{AC} is an AC input)

Set the controls so that $E_2 = E_{DC}$ is attained. Then $e_0 = A \times e_{AC}$ is obtained.

The DC component can be removed for an observation.

OFFSET voltage ranges

VOLTS/DIV	DC OFFSET voltage
5mV/div-50mV/div	more than ±1V (x1)
0.1V/div-0.5V/div	more than ±10V (x10)
1V/div – 5V/div	more than ±100V (x100)

When measured with a DMM connection, multiply the DMM reading by the multiplier written above in indentaion ( ).

Read next paragraph for the detailed explanation of measurement with a DMM connection.

(10) Measurement by the DC OFFSET function

In order to readout the voltage level digitally, connect a DMM (digital multimeter) to the DC OFFSET output terminal and set the oscilloscope to the DC OFFSET mode. See Fig. 7–2.

1) Measuring DC component

Align level ⓑ with the center graticule and read the DMM digital value. (+2V should be displayed.)

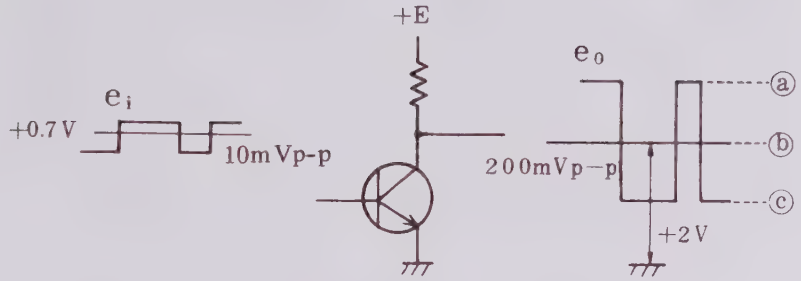


Fig. 7–2 Transistor amplifier

2) Measuring AC component

When the above is performed with an input sensitivity of 50mV, then 4 div of amplitude must be present on the oscilloscope screen.

The AC component is observable on the oscilloscope screen where as the DC component is measurable on a DMM, and there is no need for any complicated switching as such needed for conventional oscilloscopes.
More over, the DC OFFSET function provides readings of peak to peak value (p-p) of e_o on a DMM.
Align level ⓐ with the center graticule line on the screen, read the DMM value and name it V(a). Then align level ⓒ with the graticule line and readout V(c). The p-p

the difference between V(a) and V(c), and the value can be read digitally on the DMM.

As explained above, the DC OFFSET function with DC OFFSET output terminal offers an improved operational convenience and a highly accurate measurement in detailed waveform portions.

8. ADJUSTMENTS

The ATT balance of the vertical axis can be made easily.

① Set the input coupling switches of CH1 and CH2 to GND and set the TRIG MODE to AUTO. Then position the bright line to the center.

② Turn the VOLTS/DIV switch to 5mV–10mV and adjust so that the bright line does not move.
($\frac{\text{DC}}{\text{BAL}}$ ㉔ ㉕).

9. MAINTENANCE

1) Since semiconductors, precision components, etc. are employed in this oscilloscope, use at most care for operation and storage.
2) Clean the scale with soft tissue periodically.
3) Side panel can be removed with screws.
4) Store this oscilloscope in the ambient temperature from -10 to +60°C.

10. SPECIFICATIONS

CRT

Type

Large 6″ screen with internal graticule.
Approximate 12kV [2kV] acceleration potential.

Phosphor

P31 standard

Graticule

8 x 10 div (div = 10 mm)
Internal graticule

Focussing

Possible (with automatic focus correction circuit)

Trace rotation	Present
Brightness adjustment	Possible
Scale illumination	Variable

Z-AXIS INPUT (INTENSITY MODULATION

DC-coupled, positive-going signal decreases intensity: 5Vp-p signal causes noticeable modulation at normal

intensity: DC to 2MHz

Input impedance 33k ohm(typ.) [47k ohm (typ.)]

Maximum input voltage 30V (DC + peak AC)

VERTICAL DEFLECTION SYSTEM (2 identical channels)

Bandwidth and rise time

DC to at least 40MHz [20 MHz] and rise time 8.8ns [17.5 ns] or less. DC to at least 7 MHz and rise time 50ns or less at magnifier extends. The AC coupled lower -3dB point is 10Hz or less.

Deflection factor

5mV/div to 5V/div in 10 calibrated steps in a 1–2–5 sequence. Uncalibrated continuous control extends deflection factor to at least 12.5 Volts per division in the 5 Volts/div position. x5 magnifier increases sensitivity of each deflection factor setting to 1mV/div.

Accuracy

±3%
Additional error for magnifier ±2%.

Display modes

CH1, CH2 (normal or invert), Alternate, Chopped (approximate 250kHz), Added

Input impedance

Approximately 1 MΩ in parallel with 25 pF

Maximum input voltage

300V (DC + peak AC) or 500 Vp-p AC at 1kHz or less

Input coupling

AC, GND, DC

DC OFFSET Possible

DC OFFSET VOLT OUT Present

HORIZONTAL DEFLECTION SYSTEM

Time base

0.2μs/div to 0.2s/div in 19 calibrated steps in a 1 2 5 sequence. Uncalibrated continuous control extends deflection factor to at least 0.5 seconds per division in the 0.2 sec/div position. x10 mag extends maximum sweep rate to 20 ns/div [100 ns/div].

Accuracy

±3%
Additional error for magnifier ±2%

TRIGGERING SYSTEM

Trigger modes

Automatic, Normal, TV (TV-H or TV-V)

Trigger source

Internal (Ch1, Ch2 V-MODE), Line, External

Trigger slope

+, -

TV sync polarity

TV (-)

Triggering sensitivity and frequency

Frequency	Internal (V-MODE)	External
20 Hz – 5 MHz [20 Hz – 2 MHz]	0.5div (2.0 div)	200 mV
5 MHz –40 MHz [2MHz–20MHz]	1.5 div (3.0) div)	800 mV

TV-V sensitivity: SYNC section less 1 div or 1V

AUTO low band: Approximately 25 Hz

Trigger coupling

AC : 20 Hz to full bandwidth

External trigger input impedance

Approximately 1 MΩ in parallel with 30 pF

Maximum input voltage

300V (DC + AC peak)

ALT MAG Present

X-Y OPERATION (CH1; Horiz, CH2; Vert)

Deflection factor

Same as vertical deflection

X-bandwidth

DC to at least 500kHz

Phase error

3°C or less from DC to 50kHz

CALIBRATOR

An approximate 1kHz frequency 0.5V (±3%) square wave.

SIGNAL OUTPUT

CH1 VERT SIGNAL OUTPUT

Output voltage is at least 20 mV/div into a 50 ohm load.
Bandwidth is DC to at least 5 MHz.

POWER SUPPLY

VOLTAGE (50/60Hz)	FUSE
100 V (90 – 110 V)	2A
120 V (108 – 132 V)	2A
220 V (199– 242 V)	1A
240 V (216– 264 V)	1A

Power supply frequency: 50, 60, 400 Hz

Power consumption: Approx. 30W

ENVIRONMENT

Limit of operation temperature 0–+40°C

Limit of operation humidity 35–85%

Rated range of use temperature +10-+35°C

Rated range of use himidity 45–85%

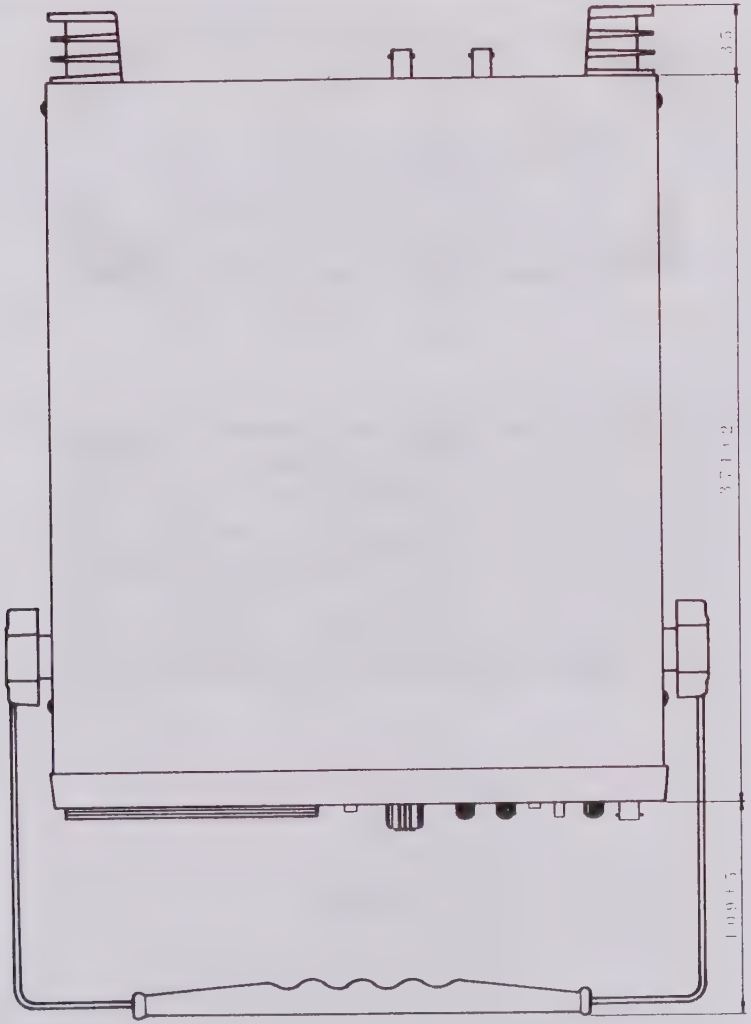
Storage and transport temperature -20–+70°C

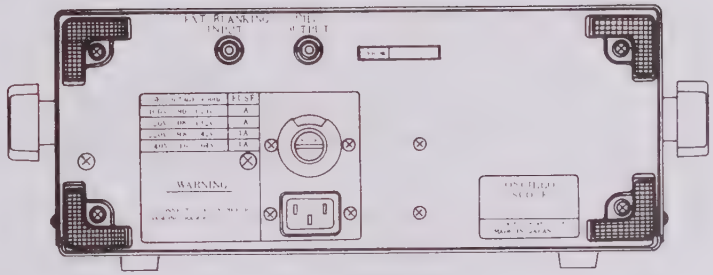
DIMENSIONS AND WEIGHT

Approx. 310(W) x 130(H) x 370(D) mm
(12.4(W) x 5.2(H) x 14.8(D) inch)

Approx. 6.5kg (14.6 lbs)

11. EXTERNAL VIEW

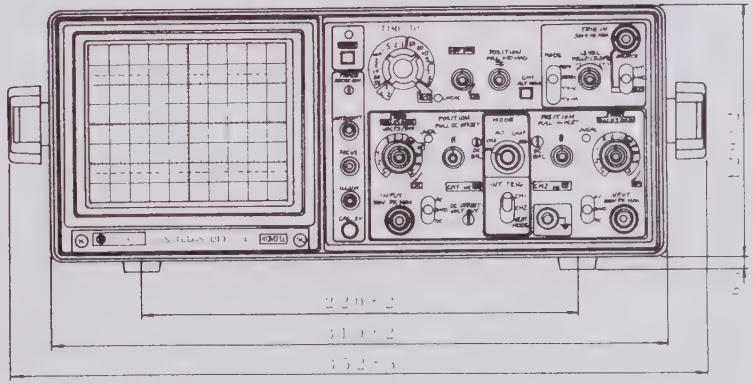




TOP VIEW

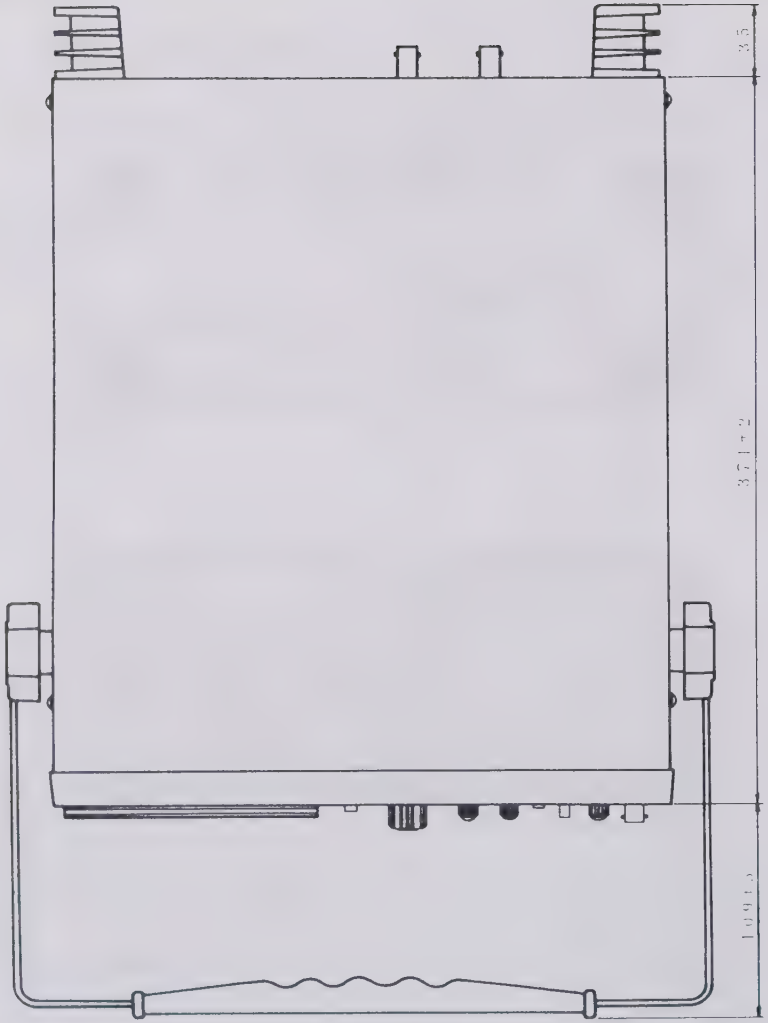
REAR VIEW

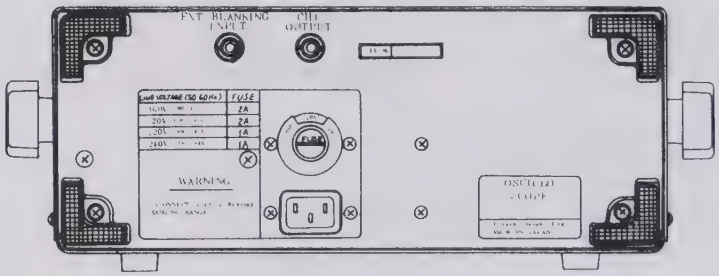
FRONT VIEW

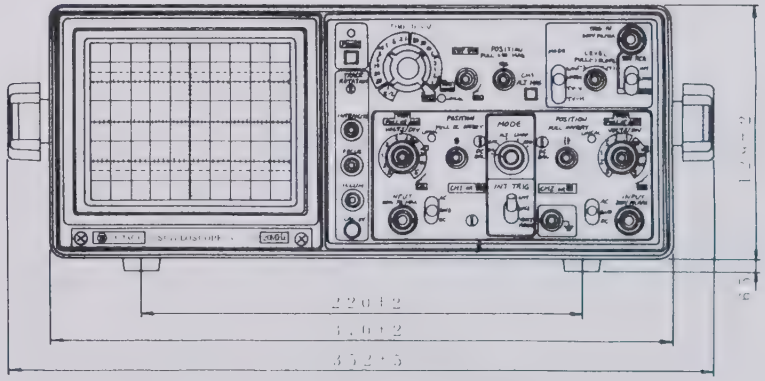


V-422

Unit: mm



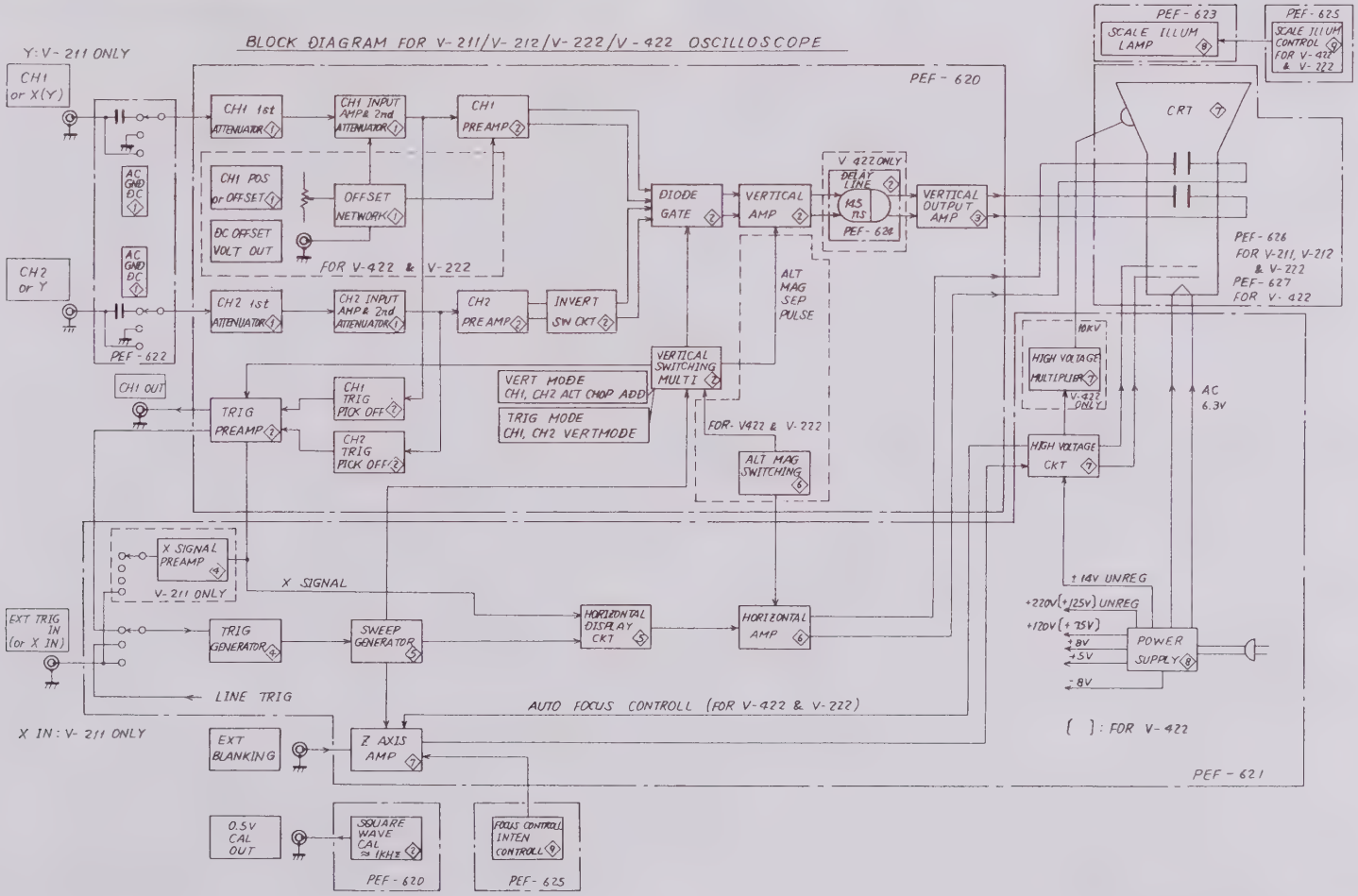




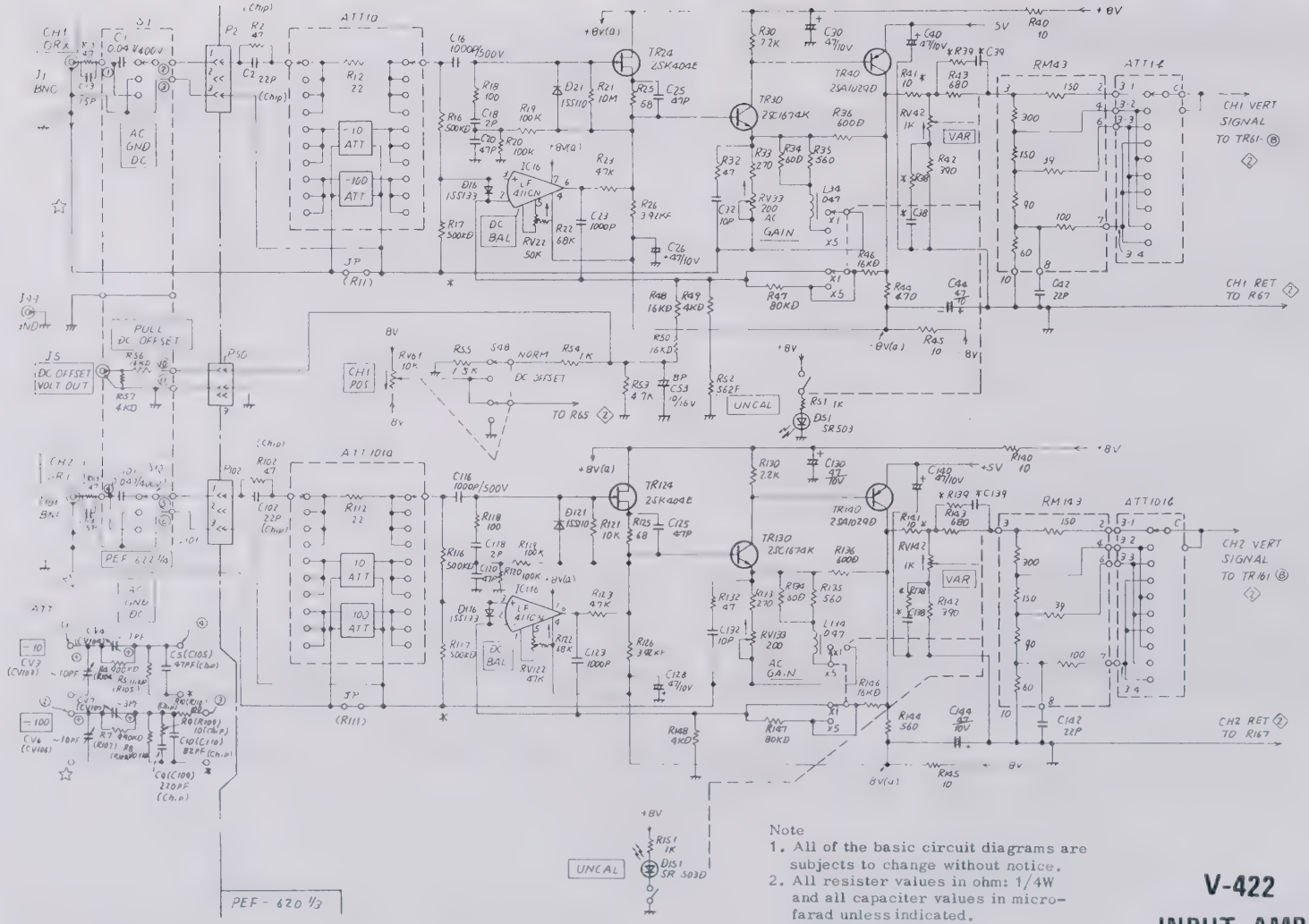
V-222

Unit: mm

12. SCHEMATIC DIAGRAMS



BLOCK DIAGRAM

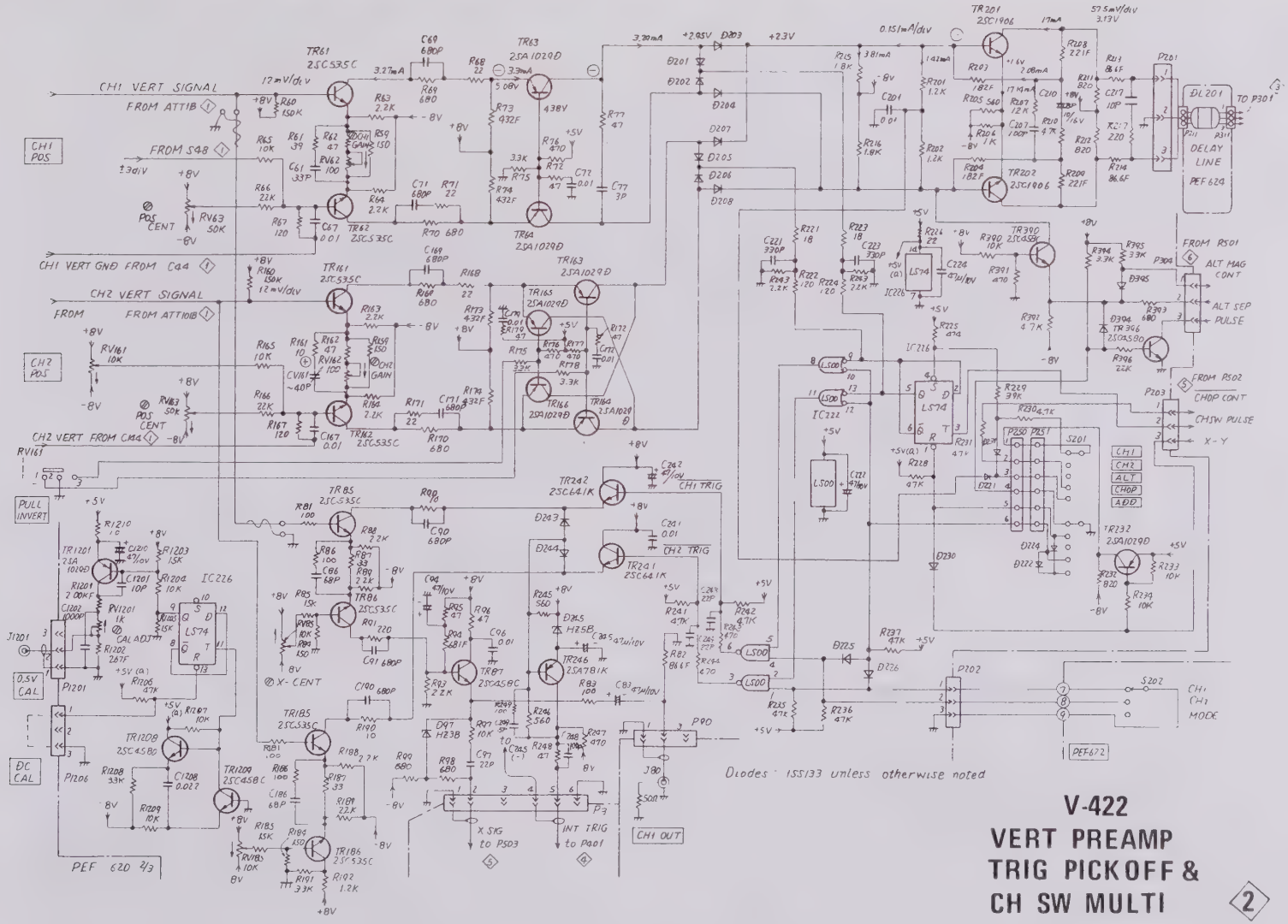


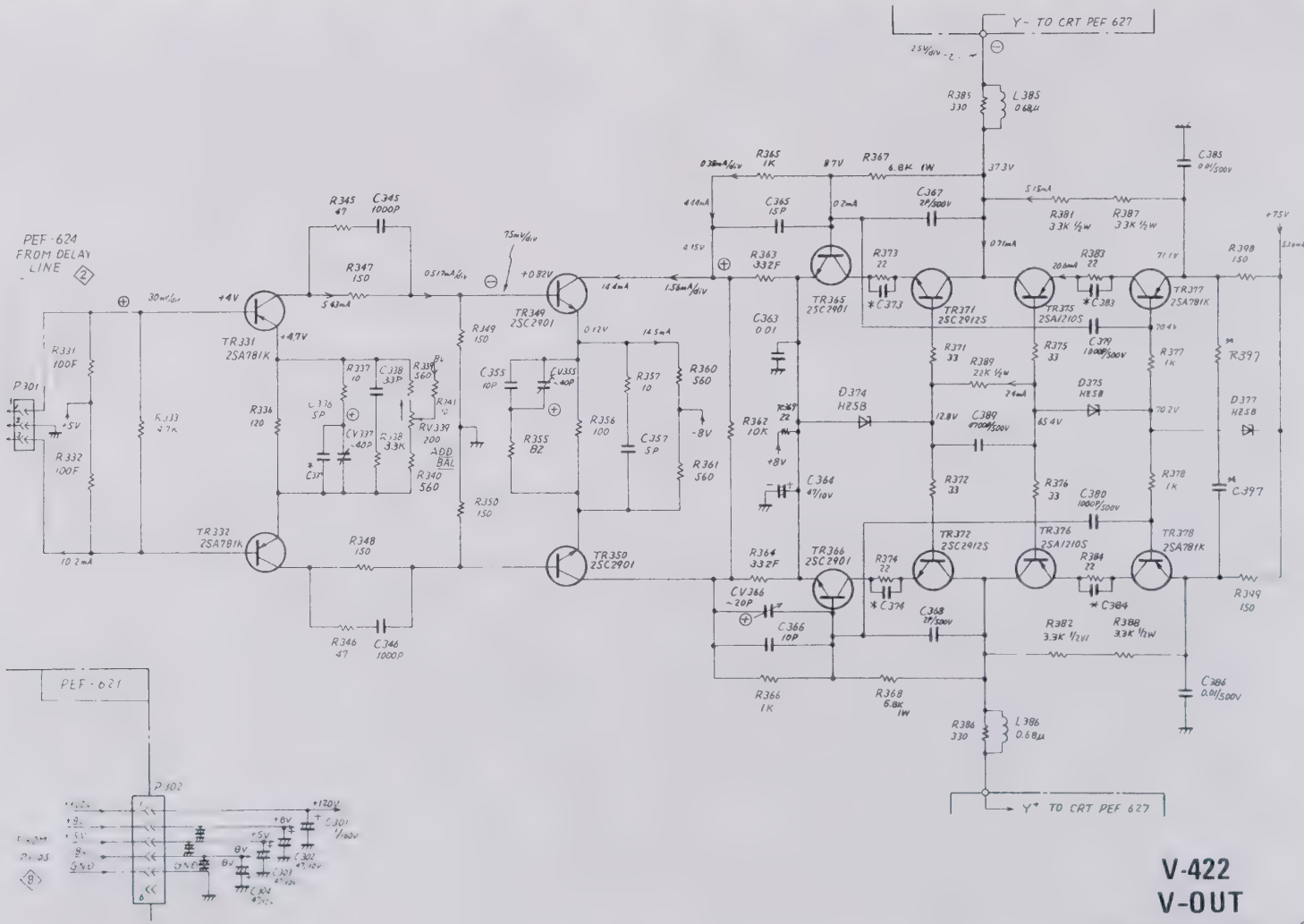
Note

1. All of the basic circuit diagrams are subjects to change without notice.
2. All resister values in ohm: 1/4W and all capaciter values in micro-farad unless indicated.
3. * Factory selected values.

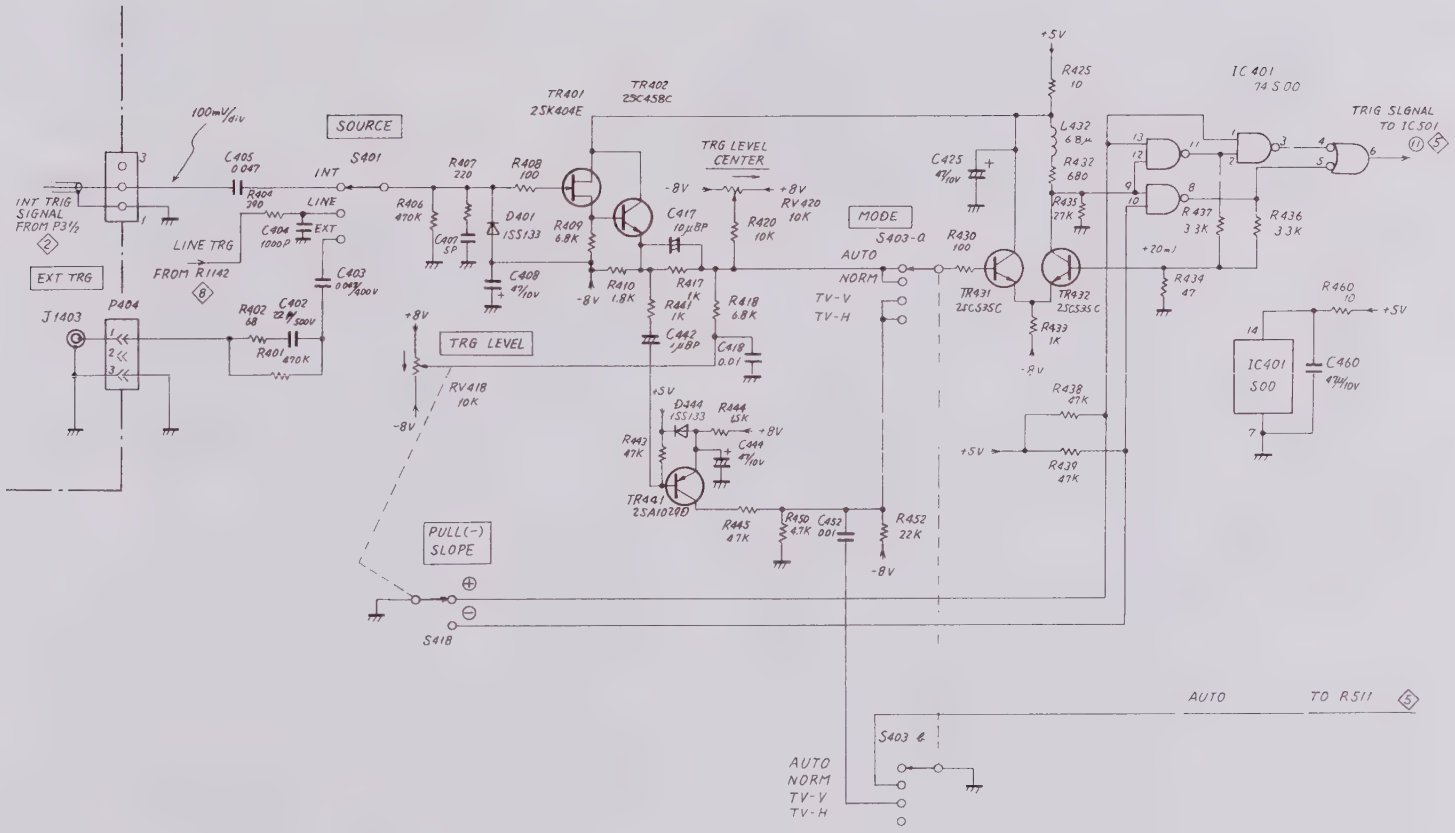
V-422

INPUT AMP ◇1

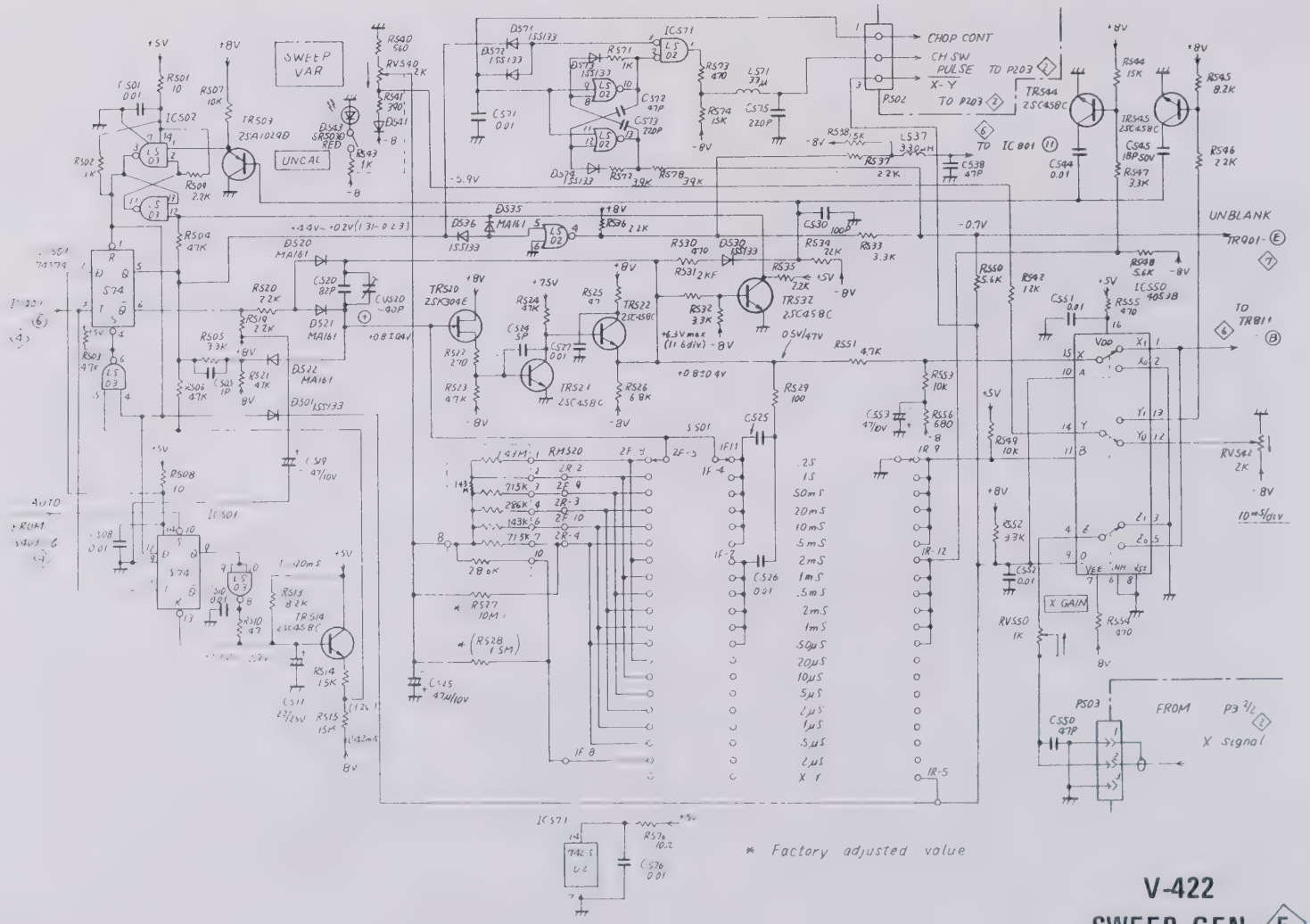

CH1 VERT SIGNAL
FROM ATT1B
FROM S48
CH1 POS
CH1 VERT GND FROM C44
CH2 VERT SIGNAL
FROM ATT1018
CH2 POS
CH2 VERT FROM C44
PULL INVERT
0.5V CAL
DC CAL
X-CENT
CAL ADJ
X SIG to P503
INT TRIG to P401
CH1 OUT
CH1 TRIG
CH2 TRIG
TO P301
DELAY LINE
FROM R501
ALT MAG CONT
ALT SEP PULSE
FROM P502
CHOP CONT
CHSW PULSE
X-Y
CH1
CH2
ALT
CHOP
ADD
MODE
Diodes 1SS133 unless otherwise noted
V-422
VERT PREAMP
TRIG PICKOFF &
CH SW MULTI
2



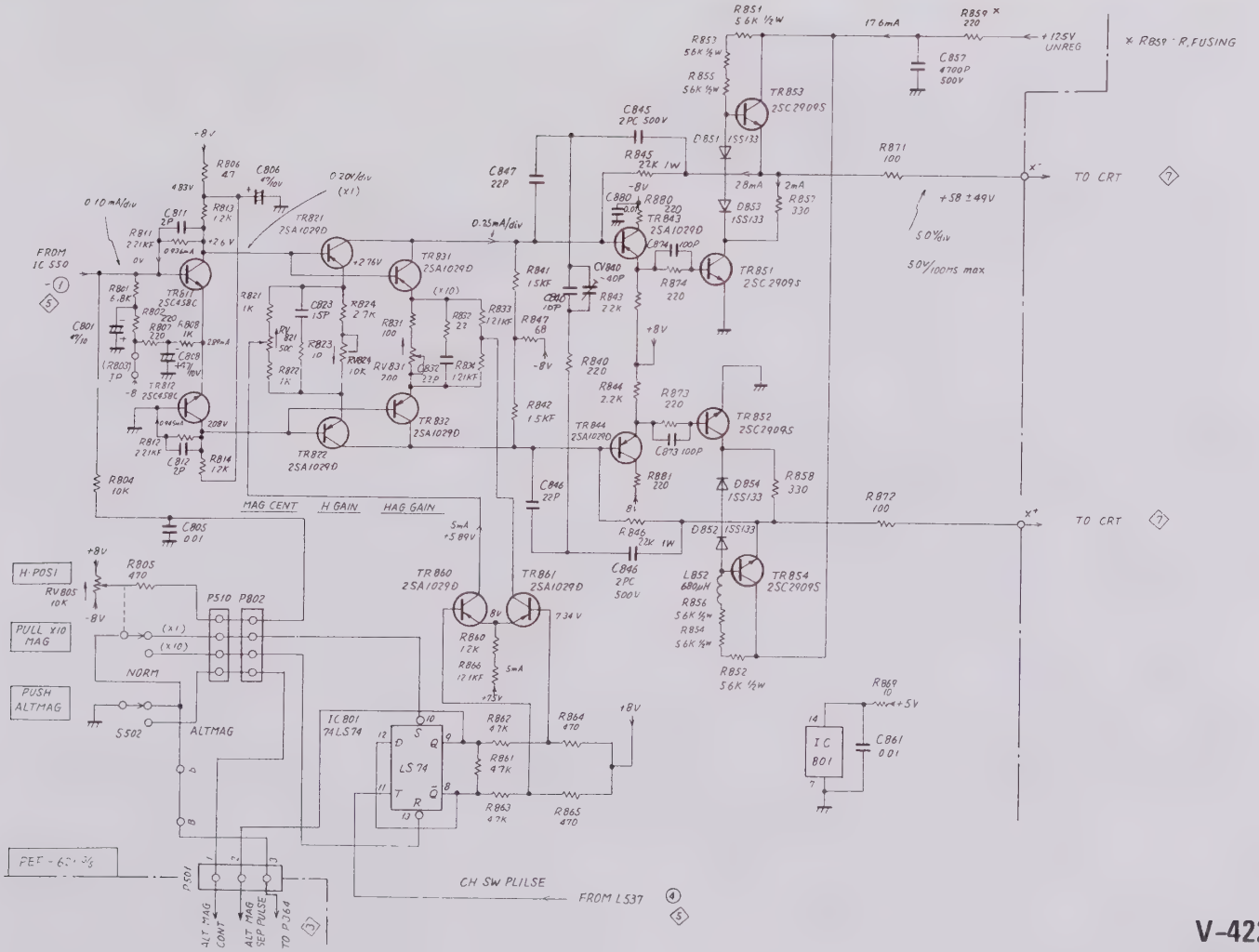
V-422
V-OUT
AMPLIFIER 3



V-422
TRIG GEN 4

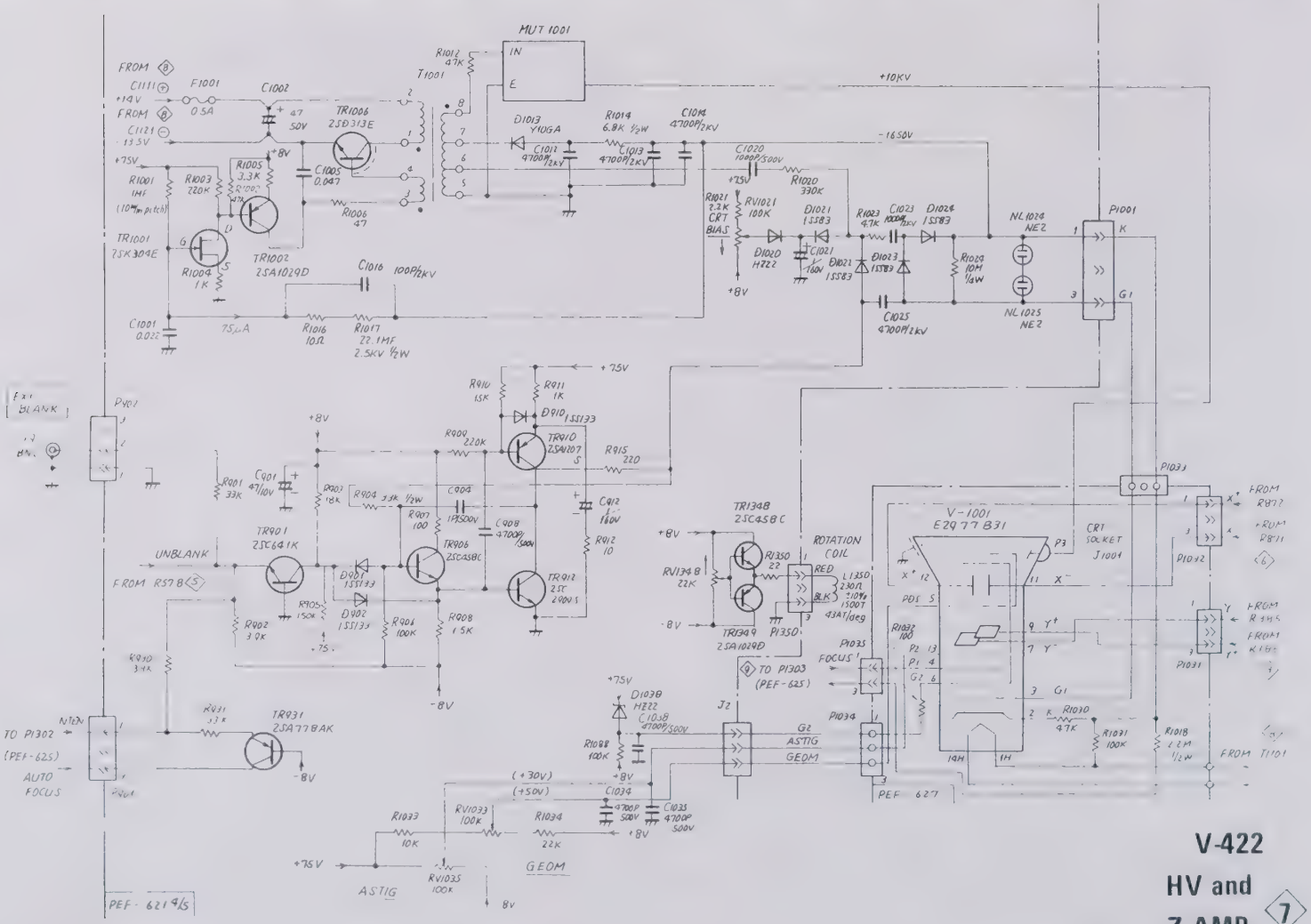


V-422
SWEEP GEN 5

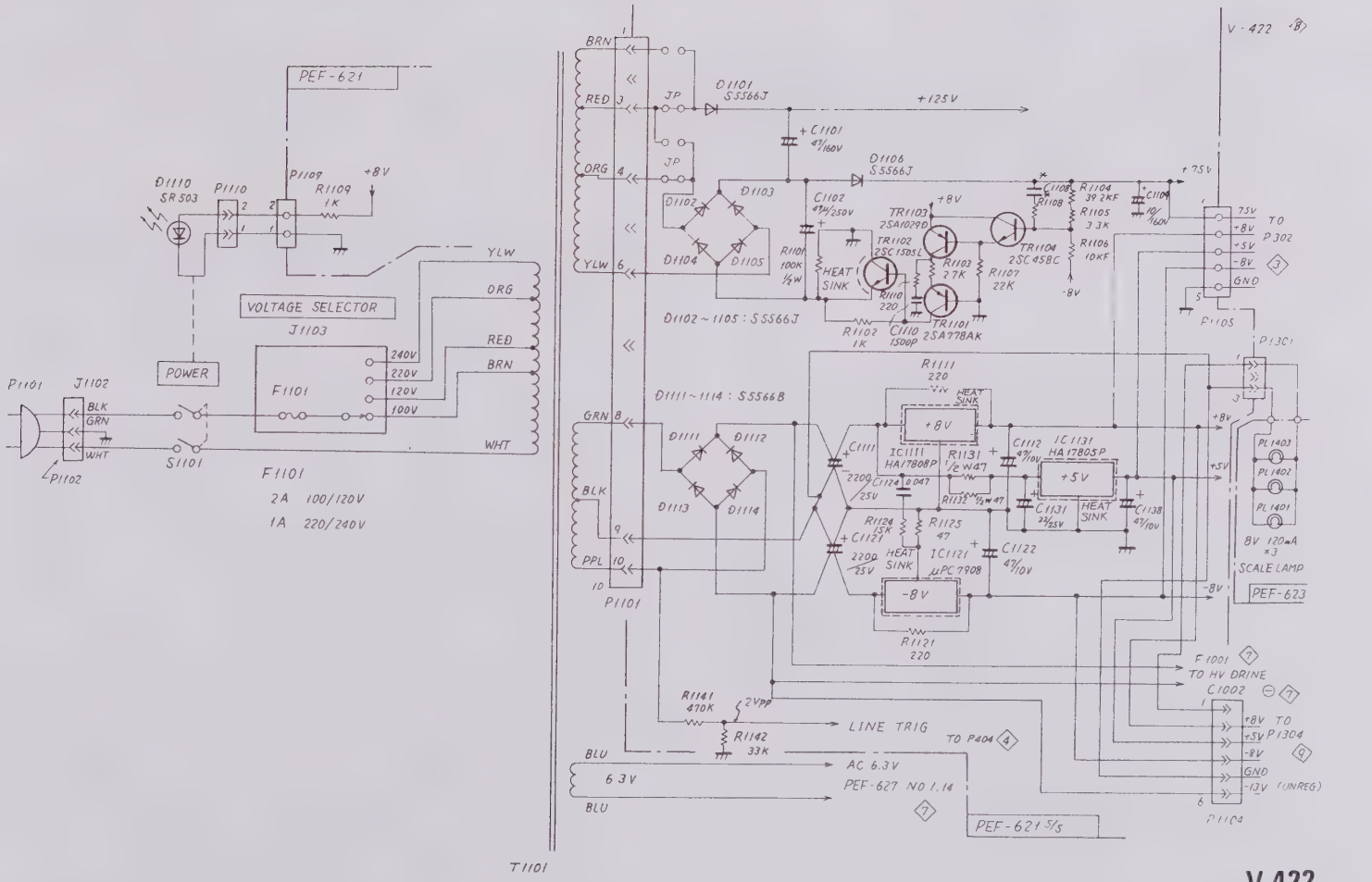

+12.5V UNREG
* RB59 : R.FUSING
TO CRT
+58 ± 4.9V
50V/div
50V/100ms max
FROM IC 550
H-POSI
PULL X10 MAG
PUSH ALTMAG
NORM
ALTMAG
S502
MAG CENT
H GAIN
HAG GAIN
IC B01 74LS74
LS 74
CH SW PLILSE
FROM LS37
TO P364
ALT MAG CONT
ALT MAG SEP PULSE

V-422

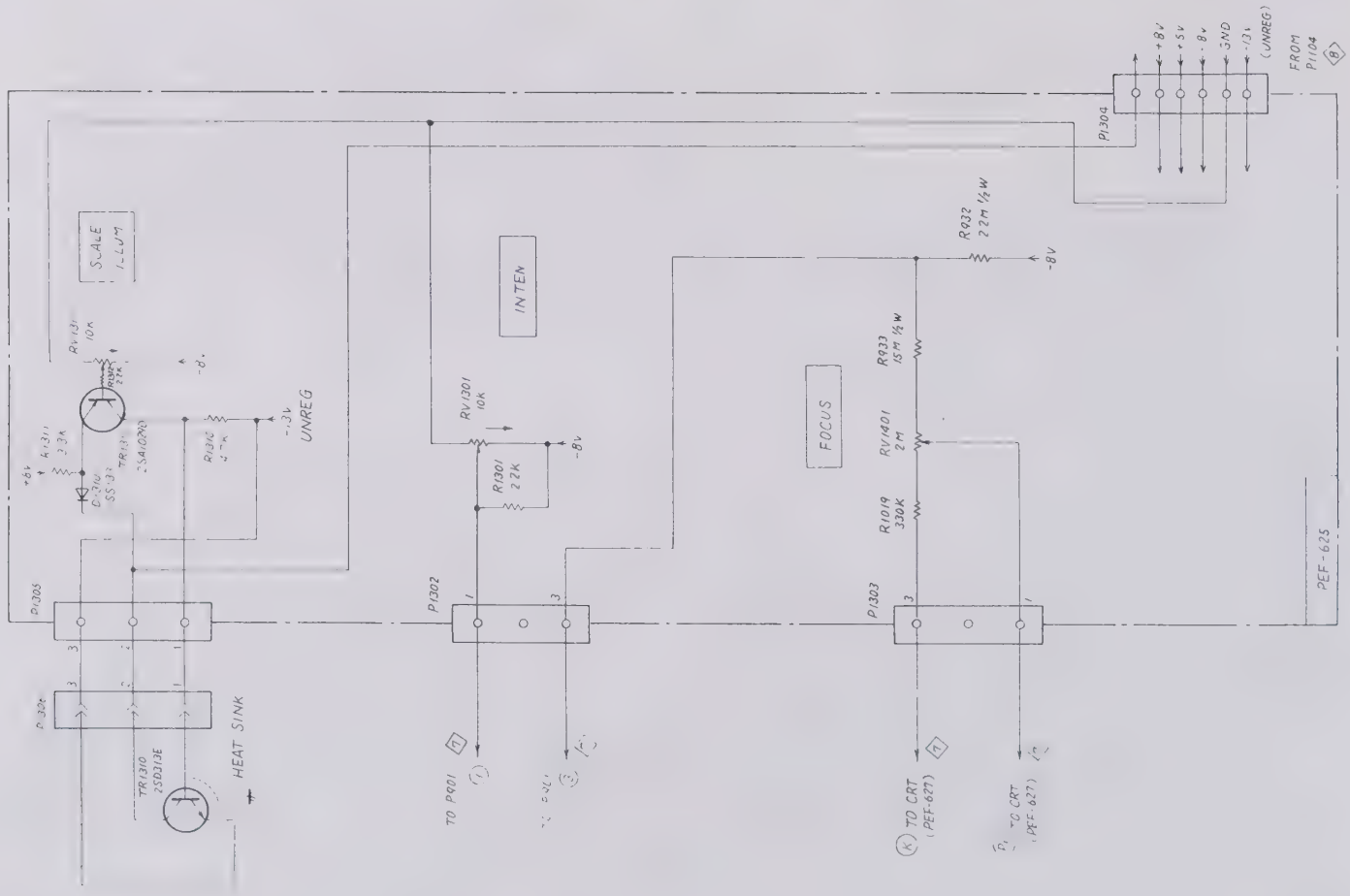
H-AMP 6



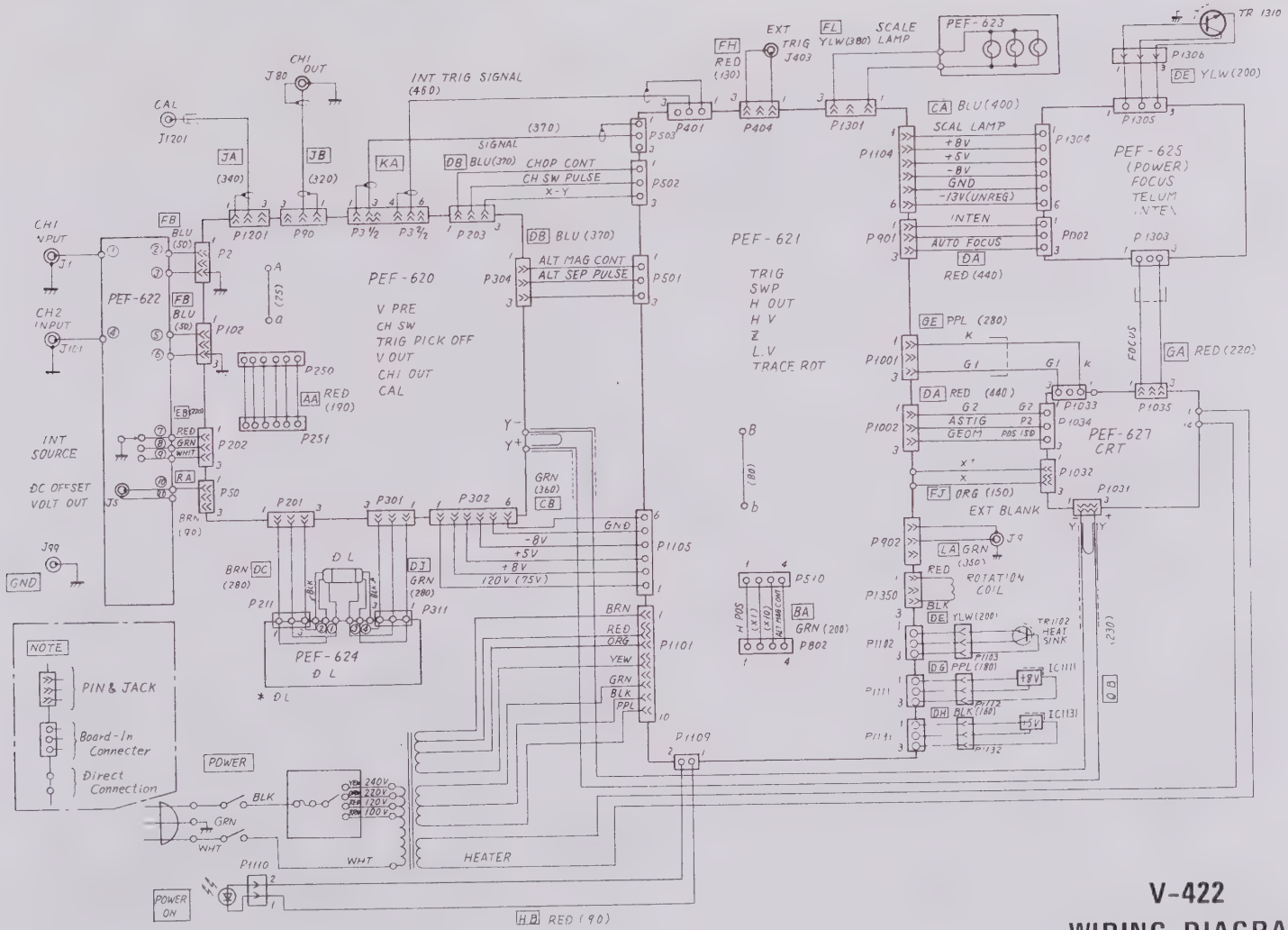
V-422
HV and Z-AMP 7



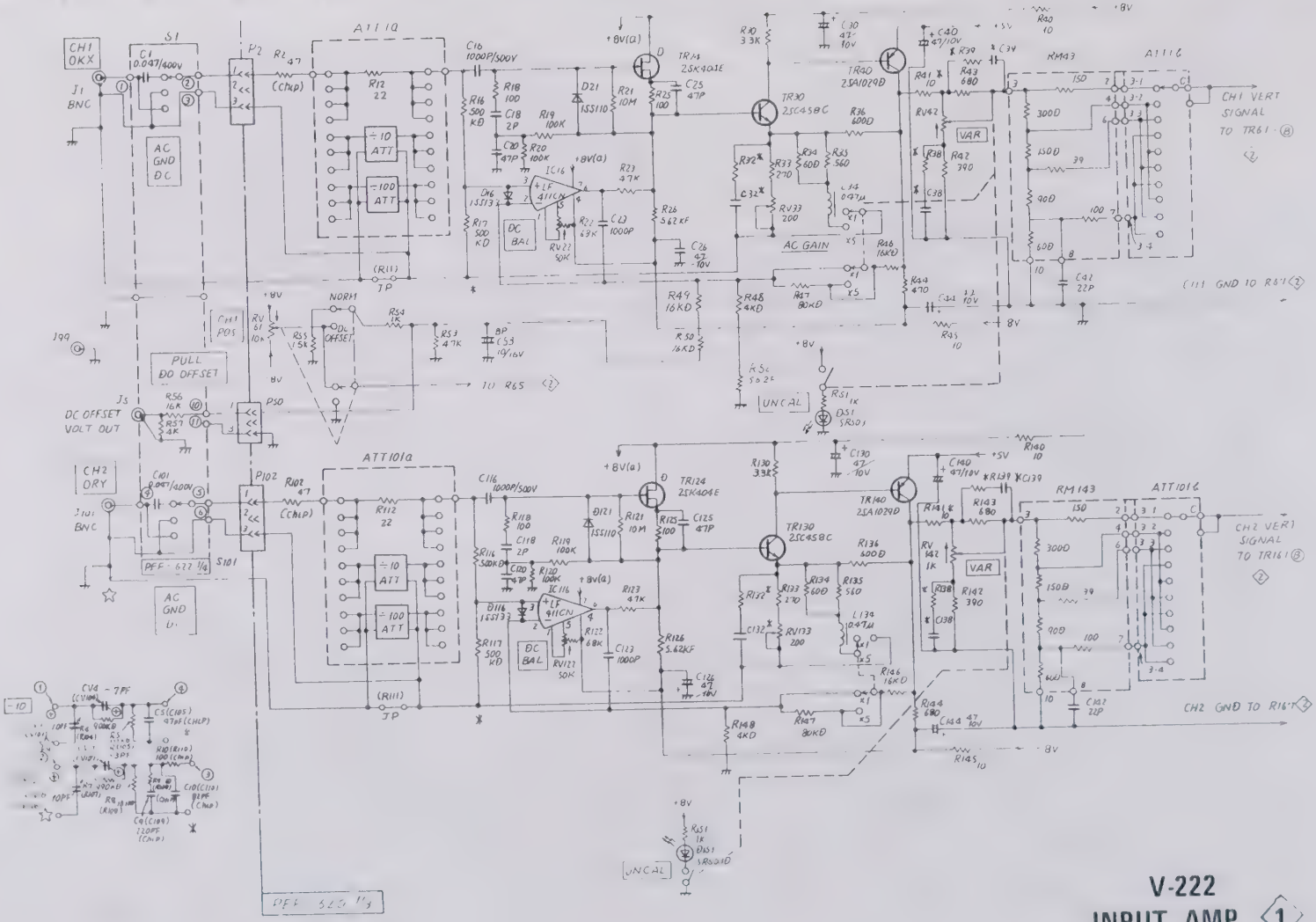
V-422
POWER
SUPPLY 8



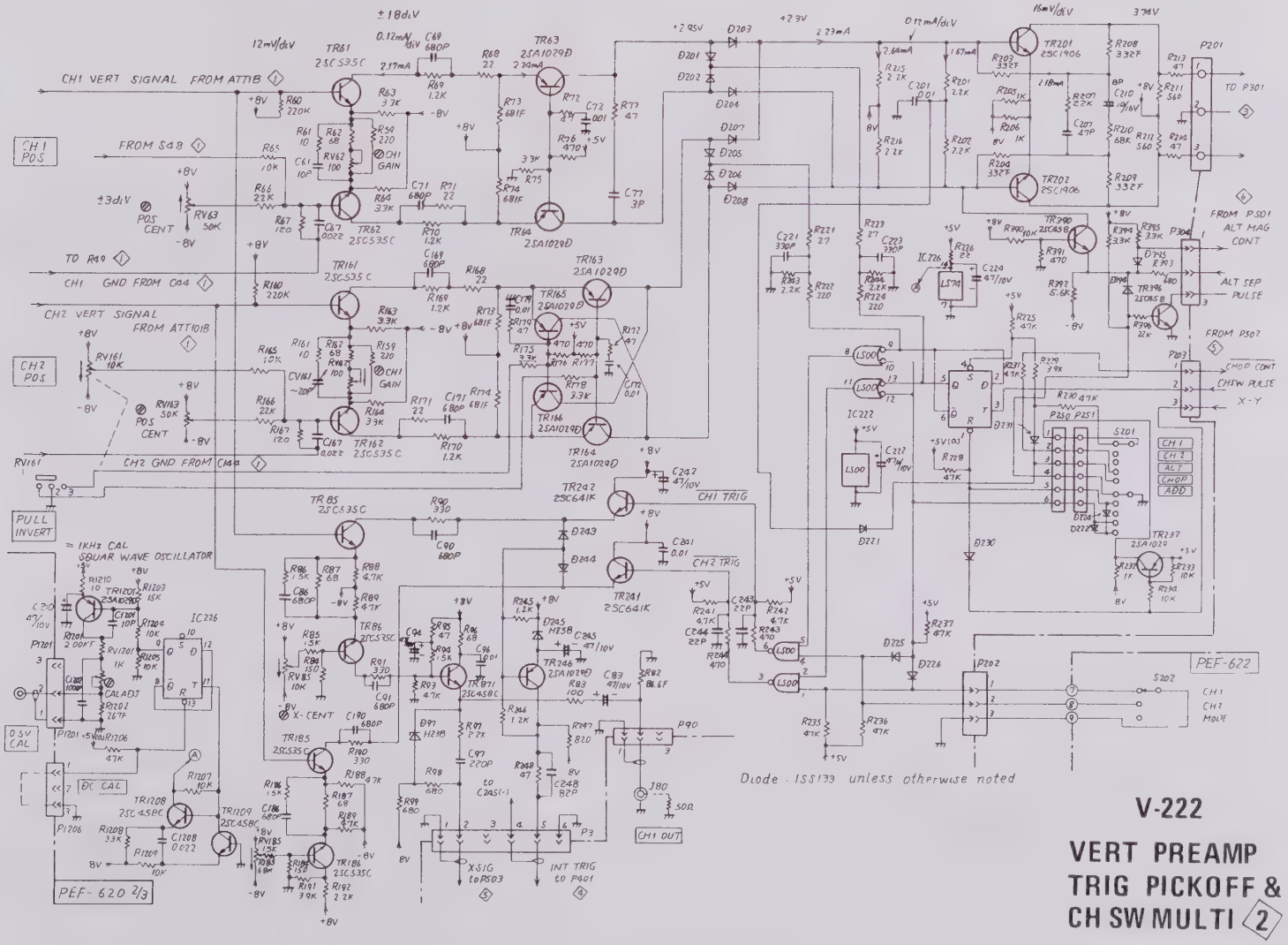
V-422
RV/LAMP 9



V-422
WIRING DIAGRAM

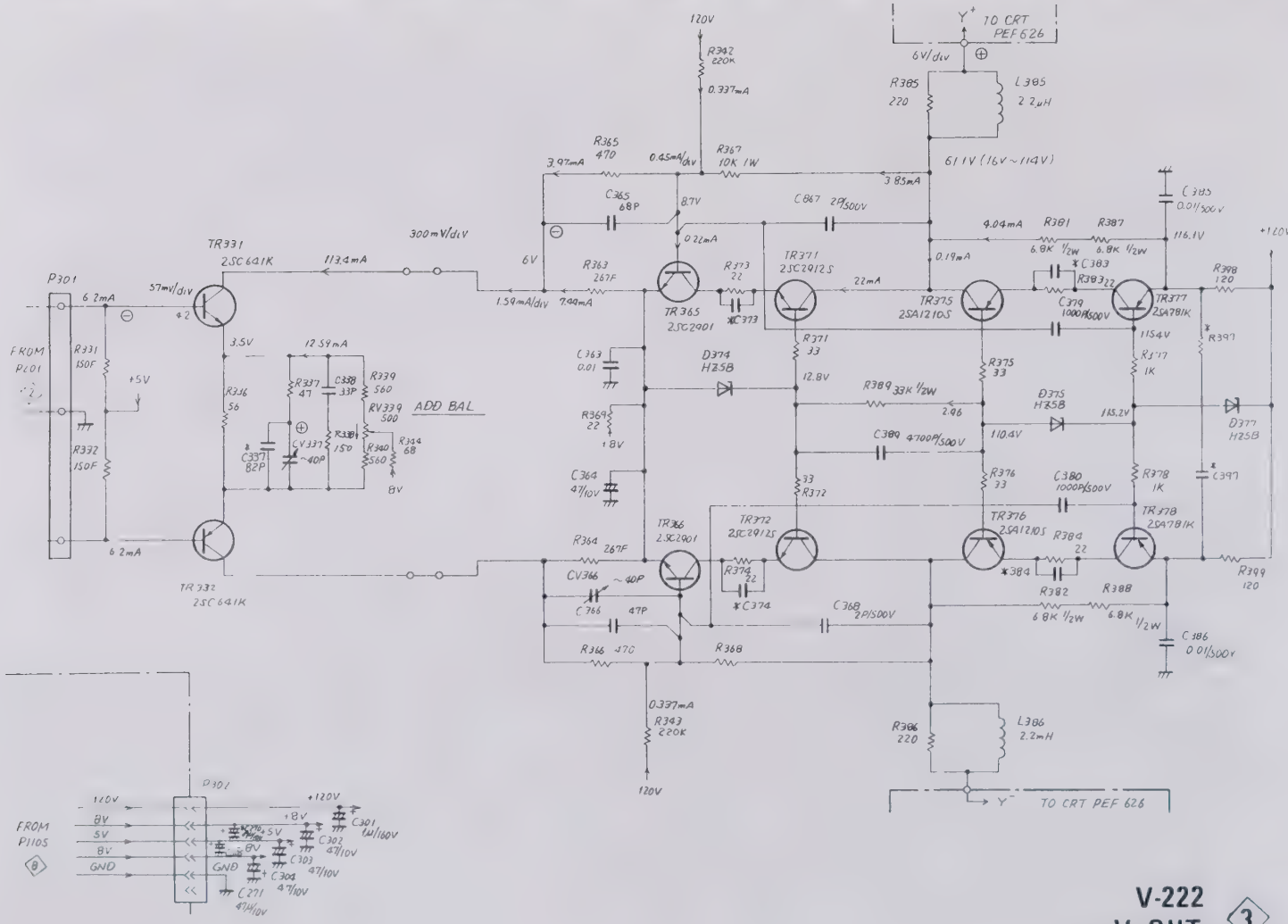


V-222
INPUT AMP (1)

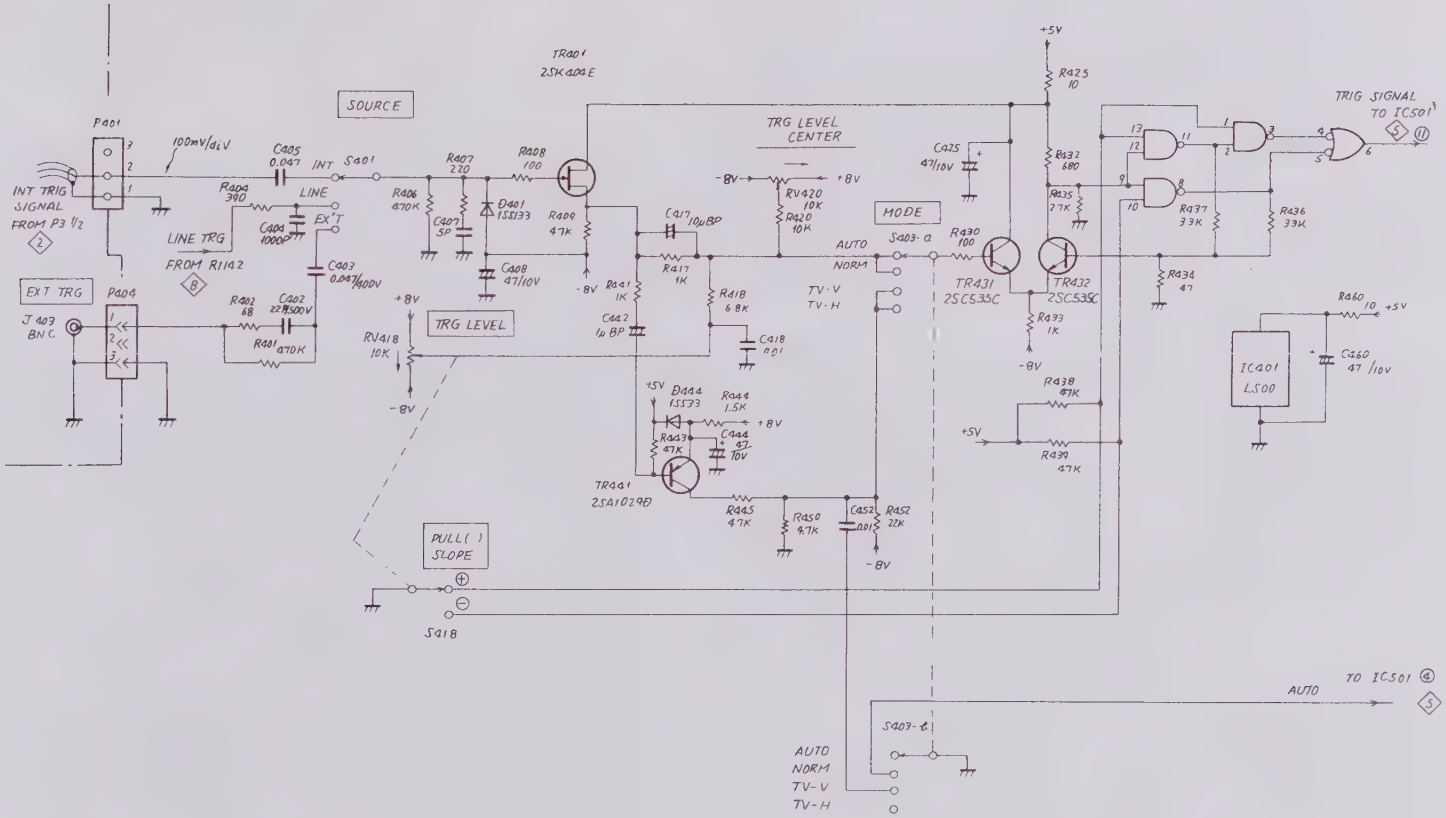


V-222

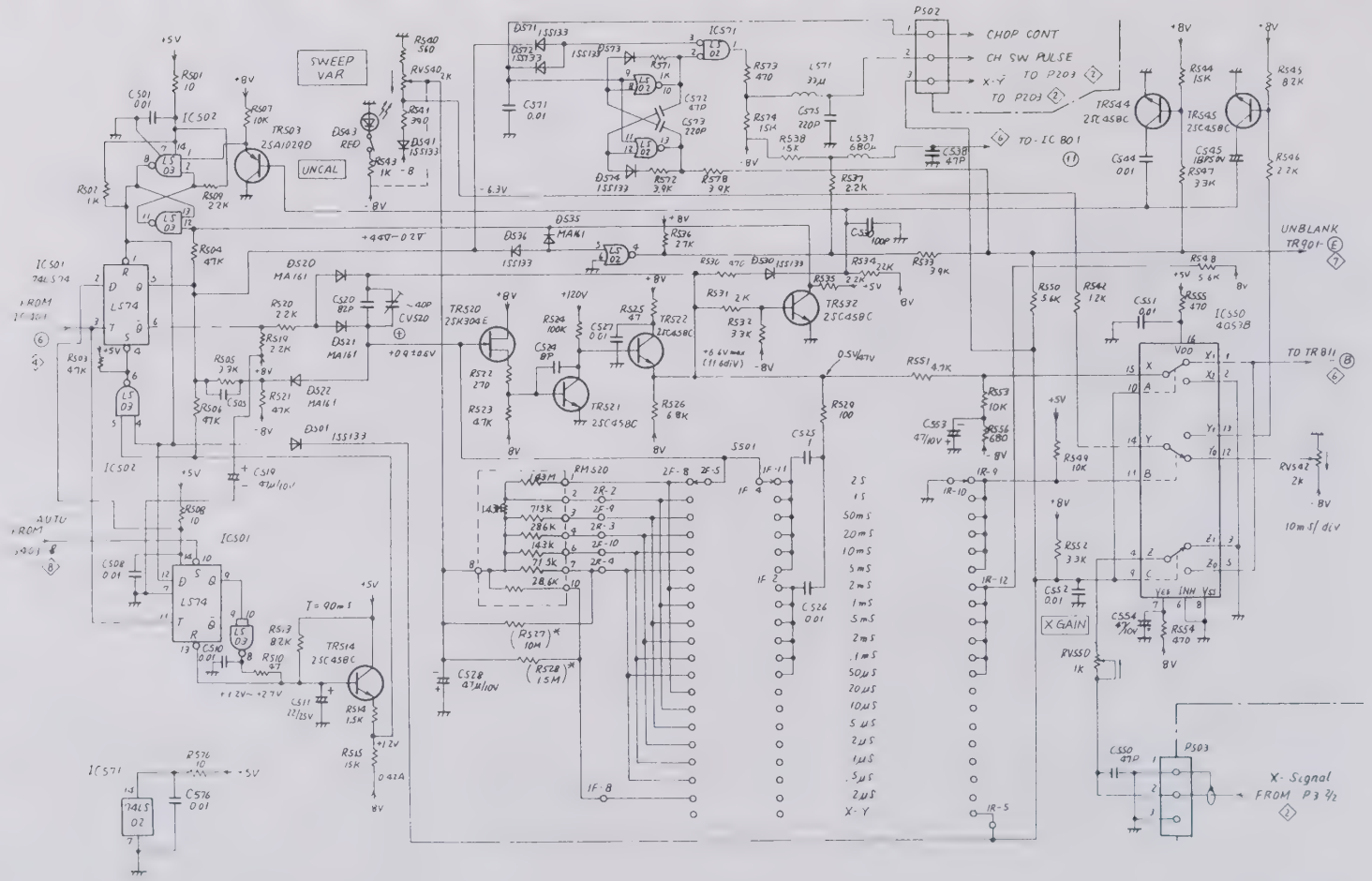
VERT PREAMP TRIG PICKOFF & CH SW MULTI (2)


120V
R342 220K
0.337mA
Y+ TO CRT PEF626
6V/div
R385 220
L385 2.2μH
R365 470
3.97mA
0.45mA/div
R367 10K 1W
3.85mA
61.1V (16V~114V)
C365 68P
8.7V
C367 2P/500V
C385 0.01/500V
0.22mA
4.04mA
R381 6.8K 1/2W
R387 6.8K 1/2W
116.1V
+120V
TR331 2SC641K
300mV/div
113.4mA
6V
R363 267F
1.59mA/div
7.94mA
TR365 2SC2901
R373 22
*C373
TR371 2SC2912S
22mA
0.19mA
*C383
R383 22
R398 120
P301
6.2mA
57mV/div
÷2
3.5V
12.54mA
TR375 2SA1210S
C379 1000P/500V
TR377 2SA781K
11.54V
R397
FROM P101
R331 150F
+5V
R336 56
R337 47
C338 33P
R339 560
RV339 500
ADD BAL
R371 33
12.8V
R375 33
R377 1K
C363 0.01
D374 HZ5B
R389 33K 1/2W
2.96
D375 HZ5B
115.2V
D377 HZ5B
R369 22
+8V
C389 4700P/500V
110.4V
C337 82P
CV337 ~40P
R338 150
R340 560
R344 68
8V
R332 150F
6.2mA
C364 47/10V
R372 33
R376 33
C380 1000P/500V
R378 1K
C397
TR332 2SC641K
TR366 2SC2901
TR372 2SC2912S
TR376 2SA1210S
TR378 2SA781K
R384 22
R364 267F
CV366 ~40P
R374 22
*C374
*C384
R399 120
C366 47P
R382 6.8K 1/2W
R388 6.8K 1/2W
C368 2P/500V
C386 0.01/500V
R366 470
R368
0.337mA
R343 220K
120V
R386 220
L386 2.2mH
Y- TO CRT PEF626
P301
120V
+120V
FROM P1105
8V
5V
8V
GND
+8V
+5V
8V
GND
C301 1W/160V
C302 47/10V
C303 47/10V
C304 47/10V
C271 47/10V

V-222
V-OUT ③

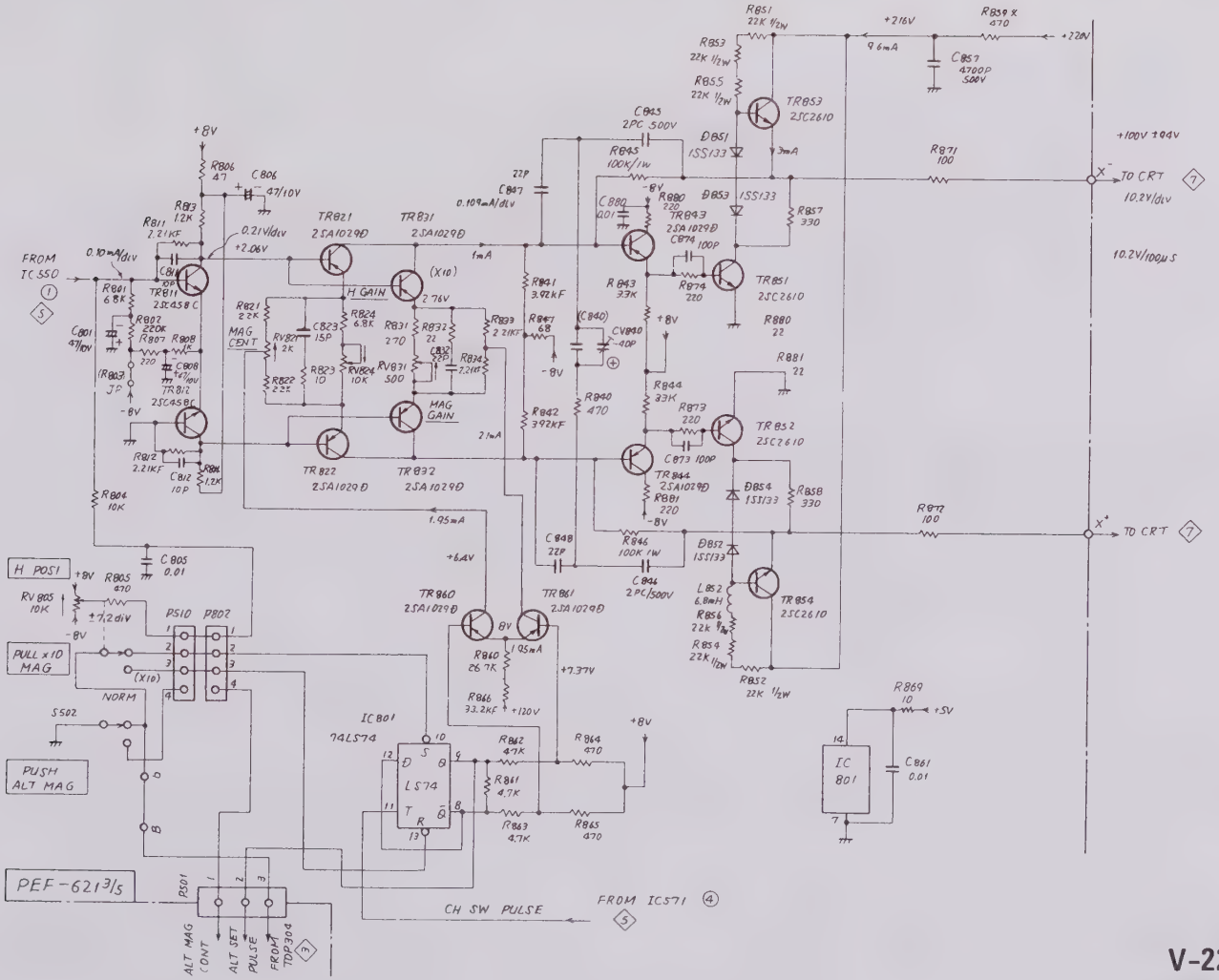


V-222
TRIG GEN 4

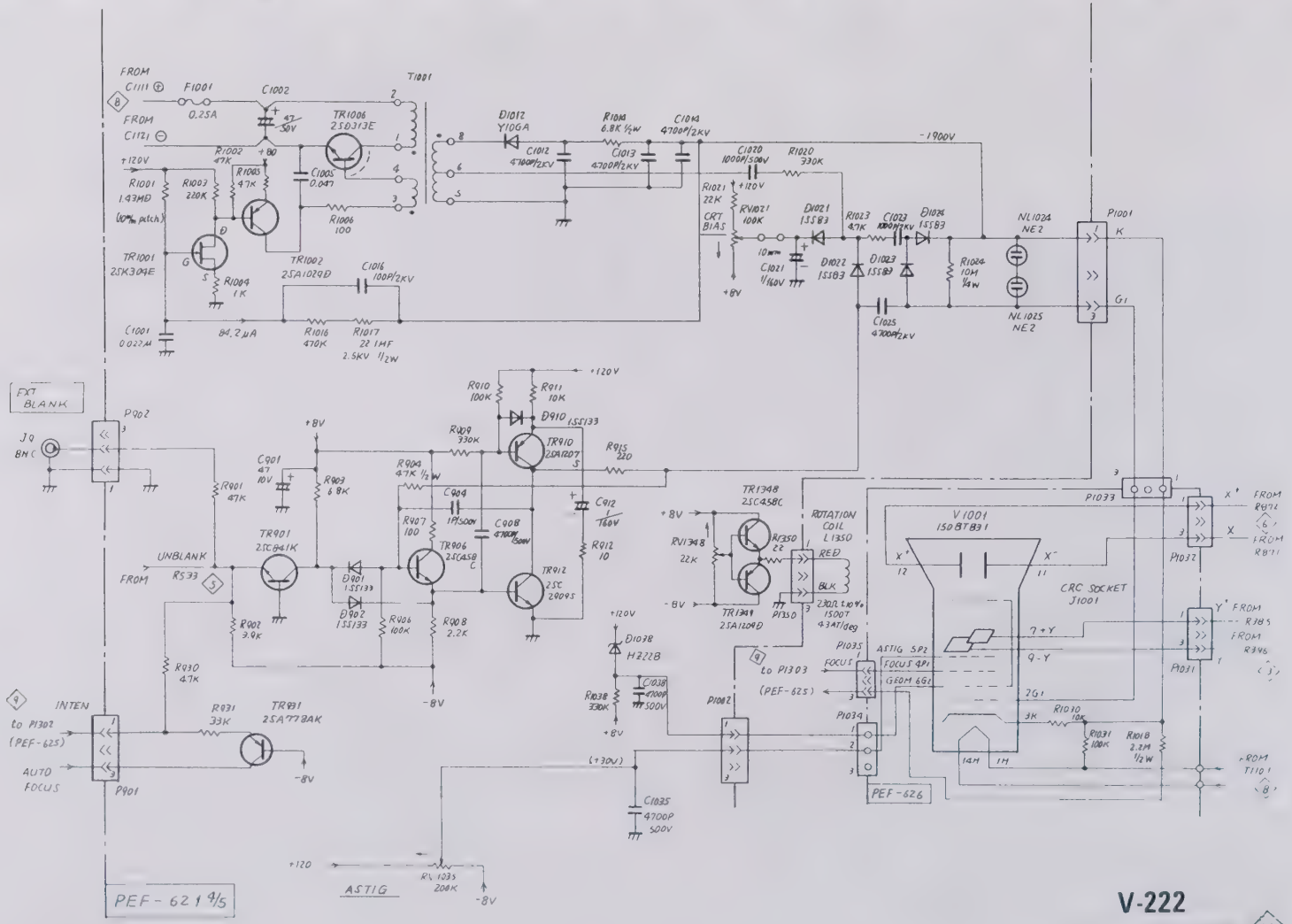


PEF-621 2/5

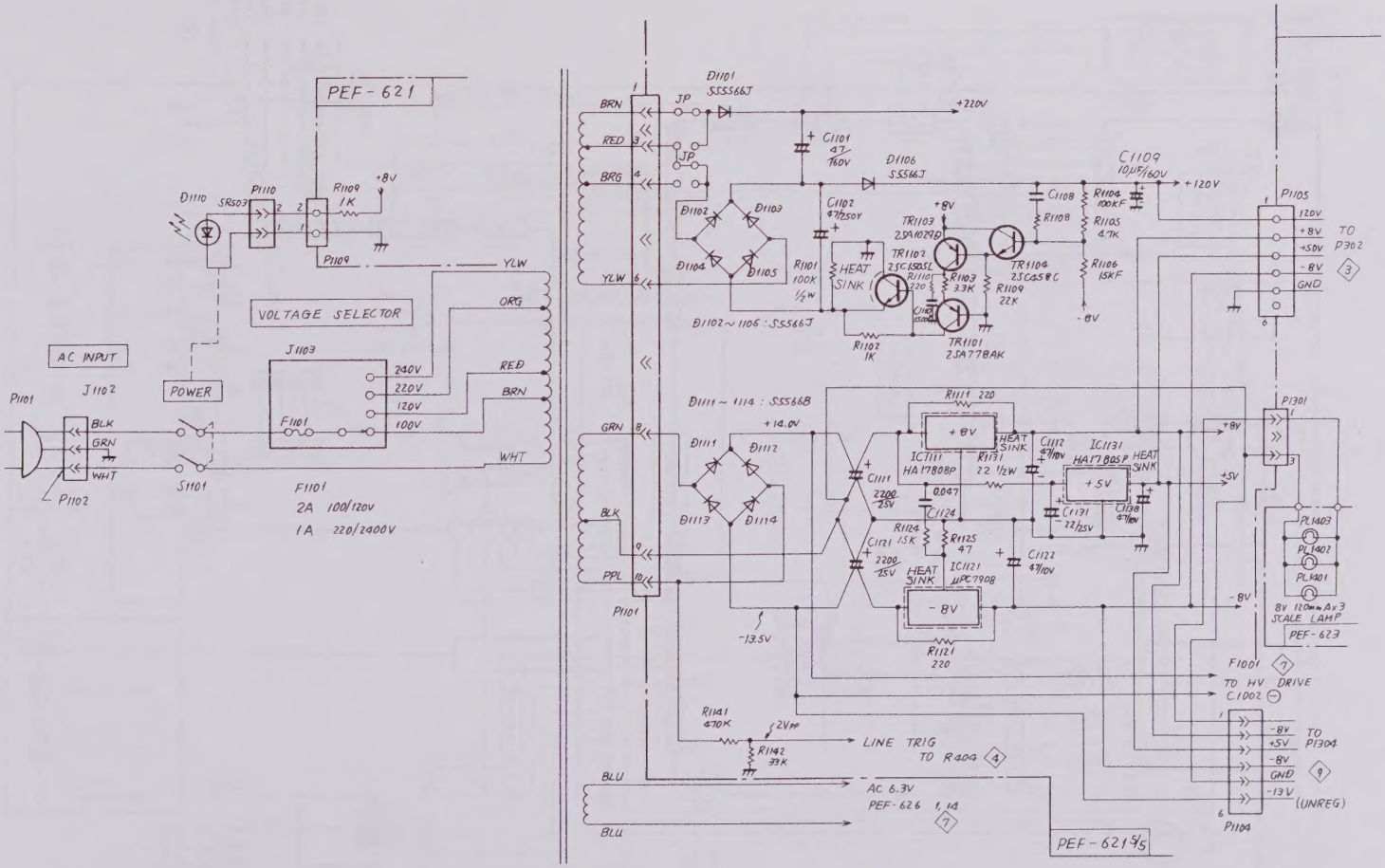
V-222
SWP GEN 5


FROM IC 550
H POSI
PULL x10 MAG
PUSH ALT MAG
NORM
(X10)
PEF-6213/5
ALT MAG CONT
ALT SET PULSE
FROM TDP304
CH SW PULSE
FROM IC571
IC801
74LS74
TO CRT
H GAIN
MAG GAIN
MAG CENT

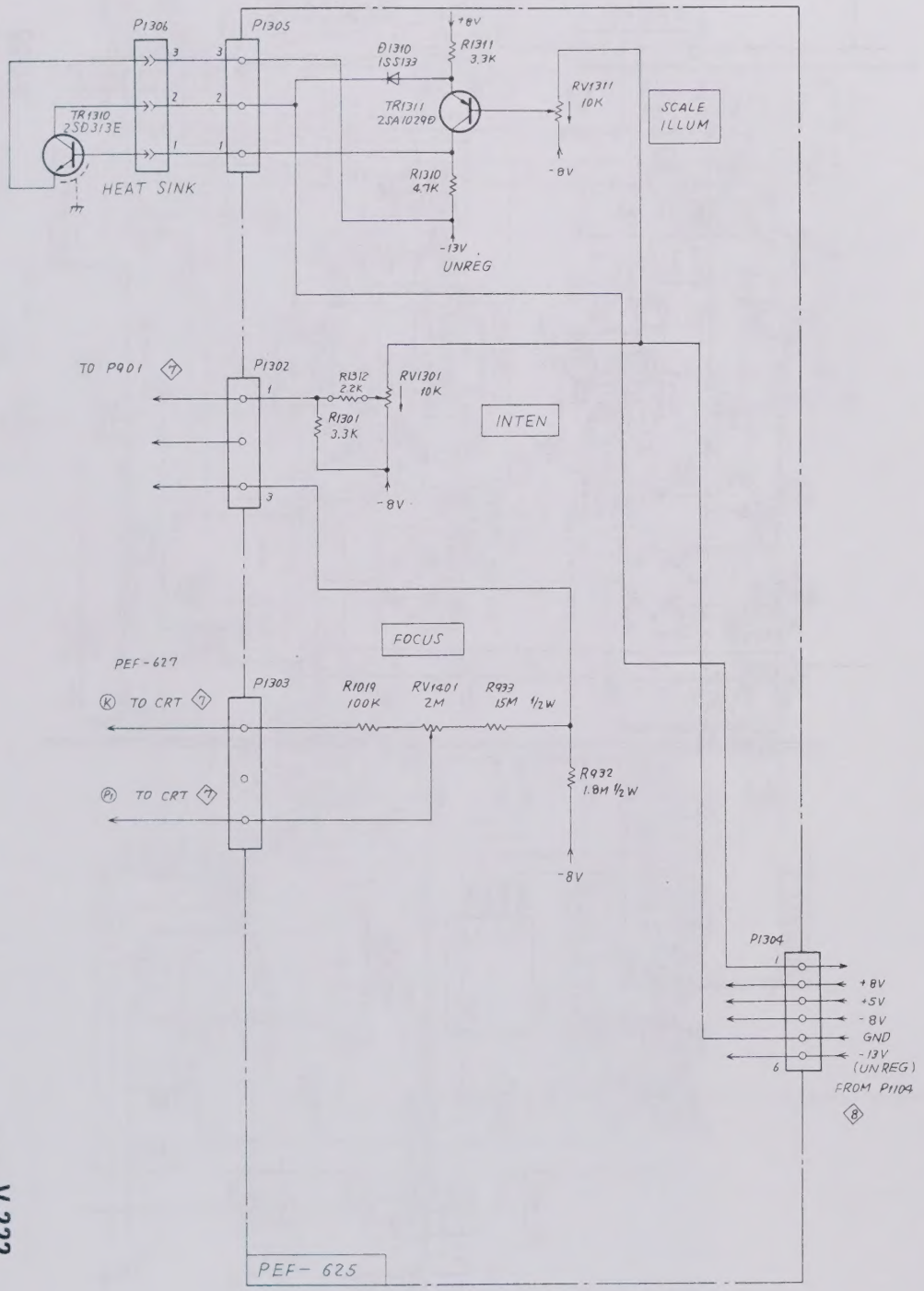
V-222
H-AMP 6



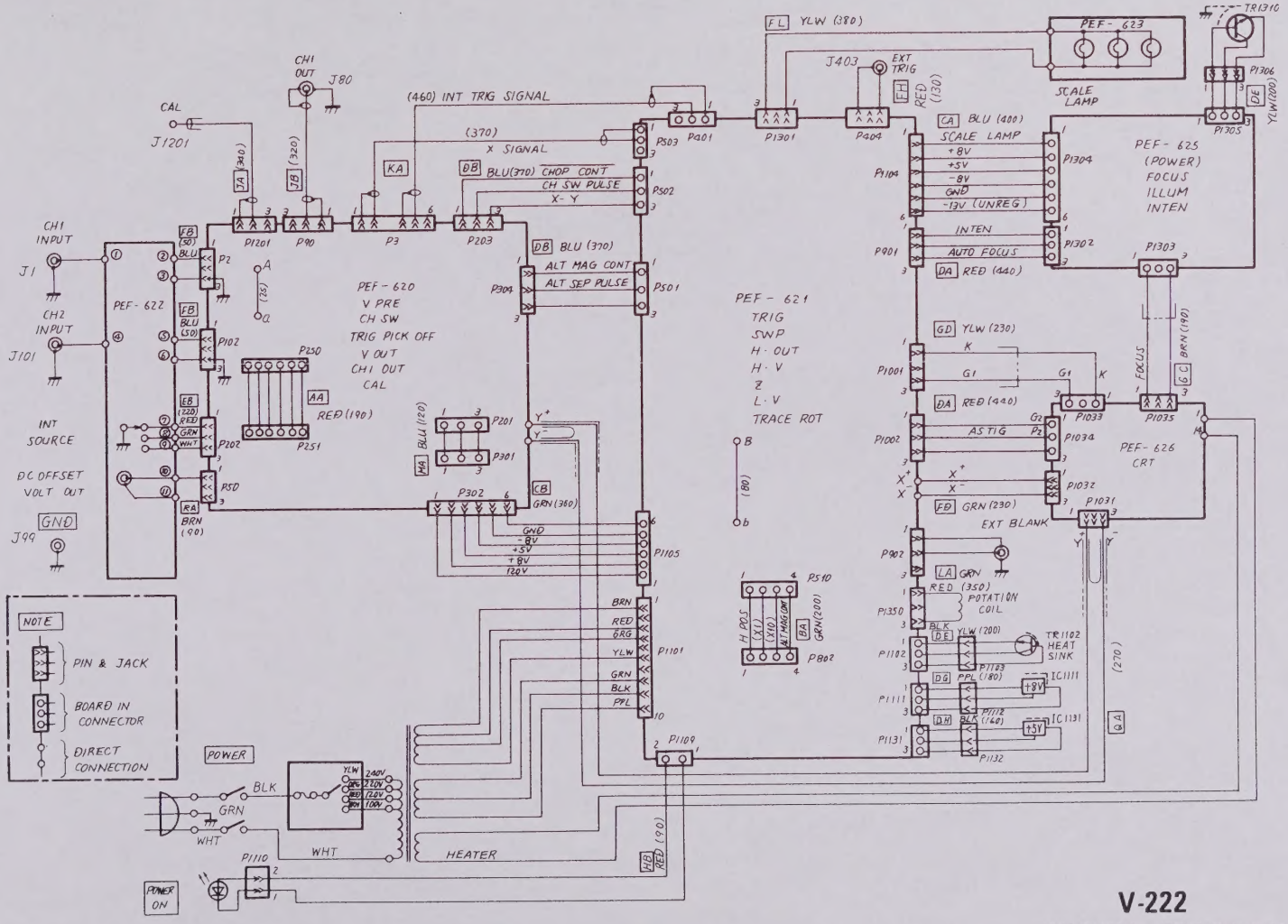
V-222
HV and Z-AMP 7



V-222
POWER
SUPPLY 8



V-222
RV/LAMP 9



V-222
WIRING DIAGRAM

MEMO: